An Enhanced View on Gravity

Why Gravity isn't equal to Everything

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Abstract.

Einstein, Planck and Boltzmann revealed with their most famous equations ($E = m.c^2$, $E = h.\upsilon$ and $S = k_B.ln(w)$ respectively) universal natural constants c, h and k_B. These constants are conversion factors between dimensions. This manuscript starts with reviewing the physical consequences thereof. This revealed major overlap in the units of measurement as found in the SI system, which blurs physical facts. The un-blurring demanded a more basic set of units of measurement. To avoid confusion in terminology, this new set was named *Crenel Physics* as opposed to *Metric Physics* (based on the SI system). The *Crenel Physics* model is step by step developed, thereby continuously showing the consistencies between both. Within *Crenel Physics*, relatively complex issues suddenly appear much simpler. This helped to further enhance insight into the fundaments of physics.

Gravity was found to be related to entropy.

The 'entropy atom' is introduced as the object with lowest required entropy value for continuous observability. It has an entropy of 2 *bits*, which –as will be shown- equals dimensionless ln(4). The gravitational constant *G* between entropy atoms was calculated (!) and found to equal: $G = \frac{h}{k_B} \times ln(4)$. Here, the term *ln(4)* represents the entropy of 'entropy atoms' in Boltzmann constants (not in *bit*). This equation delivers a value of *G* that is approximately 0.3% below its literature value. The difference is conceptually explained, and –at least directionally- this is in line with an 'improved cold atom' measurement by Rosi et.al., published in 2014, see **https://en.wikipedia.org/wiki/Gravitational_constant**.

Photons (or more in general: any object that meets Planck's equation $= h.\upsilon$) are found to have an entropy value of 1. Consequently they cannot be observed as such. We can only recapture their past existence when they hit a sensor. Consistently with above equation, the gravitational constant –when it comes to photons- is equal to: $G = \frac{h}{k_B} \times ln(1) \equiv 0$. Thus, photons are not in the least impacted by gravity. Instead, they sharply follow the gridlines in space-time, without change of internal properties. These gridlines are further apart when approaching a mass, and thus –while approaching a mass- distances stretch and clocks will start ticking slower, so that on these clocks it only appears that the photon's frequency goes up. In the past such frequency increase was falsely presumed to be caused by an energy gain while descending in a gravitational field. Likewise and consistently, gravitational lensing is not caused by a sideways gravitational acceleration of photons: in fact, photons sharply follow the regional curving of spatial gridlines near masses.

An intriguing prospect is the hypothesis of the existence of objects with an entropy value of 1 *bit*. It is reasoned that such objects might exist, but –in such case- cannot be continuously observed in any way. Yet they would be subject to (or cause) gravity, because in this case the gravitational constant is calculated as: $G = \frac{h}{k_B} \times ln(2)$, which is half the value as found between entropy atoms (of which observable matter is composed). 1 bit objects thus are a plausible candidate for representing 'black matter'.

This manuscript duplicates and enhances previous publications by the author. The reason thereof is pragmatic: it can be read as is, without references.

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1. Consolidating Units of Measurement.

Physics describes nature in terms of Units of Measurement, for which we will use symbol '*UoM*'. Thereby the Metric S.I. system is used. It presumes the meter, second, kilogram and Joule as 'base'. These are however not 'base'. This presumption blurs the fundamentals of physics. To illustrate this, consider Einstein's equation $E = m.c^2$. It can be rewritten as: $c^2 = {}^{E}/_{m}$.

Per this equation: $1\ c^2 = 1 \frac{Energy\ UoM}{Mass\ UoM} = 1\ \frac{J}{kg}$.

The light velocity c (in vacuum) then equals $1 \sqrt{{}^{J}/_{kg}}$.

However, in the S.I. system *c* is not expressed in $\sqrt{{}^{J}/_{kg}}$, but in m/s: *c* = 299.792.458 ${}^{m}/_{s}$.

Therefore: $1 \sqrt{{}^{J}/_{kg}} \equiv 299.792.458\ {}^{m}/_{s}$.

This illustrates overlap between *UoM* in the S.I. system. Per his above equation, Einstein un-blurred one of these overlaps.

In the following we will produce a consolidated system of *UoM*, eliminating all overlap. It is based on Einstein and Planck. In chapter 2 we will embed Boltzmann. To avoid confusion we refer to our consolidated system as *Crenel Physics* as opposed to 'Metric Physics'.

Because '*c*' is a universal natural constant, the equation $E = m.c^2$ describes a universal (thus non-relativistic) conversion between *mass* and *energy*. This is a decisive argument for both properties to share a common basis. That shared basis is associated with *content*. All physical objects have *content*, which can be expressed in the *mass UoM* as well as in the *energy UoM*. Therefore we can do with one (and no more than one) measure for *content*. Within the *Crenel Physics* model we will name it '*Package*' (symbol '*P*').

By expressing both *E* and *m* in *'P(ackages)'* we implicitly normalized the conversion factor c^2 in $E = m.c^2$ to *unity* (the dimensionless 1). And therefore '*c*' is also equal to unity:

$$\boldsymbol{c_{CP} \equiv 1} \qquad \text{(CP1.1)}$$

Note: in the following the subscript '*CP*' indicates that this is the *Crenel Physics* version of some property. The '*CP*' in the equation number indicates that the equation applies to the *Crenel Physics* system.

Any other velocity will be expressed as a fraction of light velocity 'c_{CP}'. Thus, within *Crenel Physics*, velocity ranges from 0 to 1.

In Metric Physics velocity is expressed in *m/s*. In *Crenel Physics*, in order to arrive at the now required dimensionless measure for velocity, the *UoM* for *distance* must be equal to the *UoM* for *time*. That measure will be named '*Crenel*' (symbol '*C*'): both distance and time will be expressed in *'Crenel'*. The *Crenel* will be our measure for *whereabouts* in terms of space and time.

Memory aid: the name *Crenel* is associated with crenels as found on top of castle walls. That shape has a pattern that can be associated with both 'distance' as well as 'frequency' (and thereby 'time').

Let's explore the *UoM* of some other physical properties. In Metric Physics acceleration 'a' is expressed in m/s^2. Therefore, in *Crenel Physics* acceleration is expressed in C/C^2 which can be simplified to C^{-1}. Based on Newton's law $F = m.a$, in Metric Physics force *F* is measured in $kg.m/s^2$ (note the overlap with the '*N(ewton)*', the typically used measure). In *Crenel Physics* the force in $kg.m/s^2$ converts to $P.C/C^2 = P/C$. From the gravitational equation $F = G.\frac{M_1.M_2}{d^2}$ we find the value of the *G* being equal to: $G = \frac{F.d^2}{M_1.M_2}$. In this equation we substitute the associated *Crenel Physics UoM*:

$G = \frac{\frac{P}{C}.C^2}{P.P} = {}^{C}/_{P}$. Thus:

$$\boldsymbol{G_{CP} \equiv 1\ \frac{C}{P}} \qquad \text{(CP1.2)}$$

In Planck's equation $E = h.\upsilon$ energy *'E'* is expressed in *Packages* and frequency $'\upsilon'$ is expressed in $Crenel^{-1}$ (the *Crenel Physics* counterpart of $seconds^{-1}$). This gives the *Crenel Physics* version of Planck's constant '*h*':

$$\boldsymbol{h_{CP} \equiv 1\ C.P} \qquad \text{(CP1.3)}$$

With three natural constants c_{CP}, G_{CP} and h_{CP} defined, we now have the following three equations:

For light velocity *c*:
1 (dimensionless) = c (m.s^{-1}) (1.4)

For Planck's constant *h*:
1 P.C = h (N.m.s) (1.5)

For the gravitational constant *G*:
1 C.P^{-1} = *G* (Nm^{2}kg^{-2}) (1.6)

The left sides in the above equations express the natural constants (c_{CP}, h_{CP} and G_{CP} respectively) in *Crenel Physics UoM* whereas the right sides express these in Metric Physics *UoM*. From these three equations we can extract *P* and *C*, and express these in Metric *UoM* as follows:

In equation (1.5) the symbol 's' in the *UoM* can be replaced by *c* meters because 1 second corresponds to *c* meters. This results in:

$$1.P.C = h.c\ (N.m^2) \tag{1.7}$$

Based on Einstein's $E=m.c^2$, 1 kg corresponds to c^2 Joules or c^2 *(N.m)*. In equation (1.6) the kg^{-2} in the *UoM* can therefore be replaced by c^{-4} $(N^{-2}.m^{-2})$:

$$1\ C.P^{-1} = G.c^{-4}\ (N.m^2.N^{-2}m^{-2}) = G.c^{-4}\ (N^{-1}) \tag{1.8}$$

Dividing equation (1.7) by equation (1.8) gives:

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

Or:

$$\mathbf{1\ Package} = \sqrt{\frac{h.c^5}{G}}\ (\mathbf{Joules}) \tag{1.9}$$

=4.9033x10^{9} J

Because 1 Joule equals c^{-2} kg:

$$\mathbf{1\ Package} = \sqrt{\frac{h.c}{G}}\ (\mathbf{kilogrammes}) \tag{1.10}$$

=5.4557x10^{-8} kg

Based on $E = h.\upsilon$, equation (1.9) can 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:

$$\mathbf{1\ Package} = \sqrt{\frac{c^5}{h.G}}\ (\mathbf{Hertz}) \tag{1.11}$$

=7.4001x10^{42} Hz

Multiplying equation (1.7) with equation (1.8) gives:

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

Or:

$$\mathbf{1\ Crenel} = \sqrt{\frac{h.G}{c^3}}\ (\mathbf{meter}) \tag{1.12}$$

=4.0512x10^{-35}m

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

$$\mathbf{1\ Crenel} = \sqrt{\frac{h.G}{c^5}}\ (\mathbf{seconds}) \tag{1.13}$$

=1.3513x10^{-43}s

Equations (1.9) through (1.13) show resemblance with the well-known Planck's natural *UoM*, albeit that the above equations hold Planck's constant 'h', whereas Planck's *UoM* hold the *reduced* Planck constant '*h/2.π*' (symbol '$\hbar$'). Had for Planck's equation $E = h.\upsilon$ the alternate version $E = \hbar\omega$ been used in the above, this would have led to full consistency with Planck's units of measurement.

> *Crenel Physics* is frequency based, whereas Planck's *UoM* are based on *angular* frequency.

The above demonstrates how a consolidated system of *UoM* –based on *Crenel* and *Package* only- nevertheless delivered a set of measures for mass, energy, frequency, time and distance, based on universal natural constants only. And moreover: these are consistent with the historically known Planck *UoM*.

With *c* normalized to dimensionless 1, in *Crenel Physics* we can simplify the found measures:

$$\mathbf{1\ P} = \sqrt{\frac{h_{cp}}{G_{cp}}} \quad \text{in } energy\ UoM \tag{CP1.14}$$

$$\mathbf{1\ P} = \sqrt{\frac{h_{cp}}{G_{cp}}} \quad \text{in } mass\ UoM \tag{CP1.15}$$

$$\mathbf{1\ P} = \sqrt{\frac{1}{h_{cp}.G_{cp}}} \quad \text{in } frequency\ UoM \tag{CP1.16}$$

$$\mathbf{1\ C} = \sqrt{\mathbf{h_{cp}.G_{cp}}} \quad \text{in } distance\ UoM \tag{CP1.17}$$

$$\mathbf{1\ C} = \sqrt{\mathbf{h_{cp}.G_{cp}}} \quad \text{in } time\ UoM \tag{CP1.18}$$

Note that –as indicated- these equations are valid in the *Crenel Physics* system of *UoM* (or for that matter: in any other system of *UoM* in which light velocity 'c' has been normalized to a dimensionless 1).

Equation (CP1.16) universally converts *Packages* to frequency units, thus to *Crenel*$^{-1}$. Consequently, there is a universal relationship between both. To see the implication of this equation, we first review the mathematical procedure to convert *content* (per (CP1.14) or (CP1.15)) to *whereabouts* (per (CP1.17) or (CP1.18)).

That conversion procedure consists of two steps:

1. INVERT (the conversion factor)…. this gives $\sqrt{\frac{G_{cp}}{h_{cp}}}$
2. MULTIPLY the result with Planck's constant 'h_{cp}'. This gives $\sqrt{h_{cp}.G_{cp}}$, which matches (CP1.17) and (CP1.18).

Applying this procedure to the *Package* gives:

$$P \xrightarrow{\text{Step 1}} \frac{1}{P} \xrightarrow{\text{Step 2}} \boxed{\frac{h}{P} = \mathrm{C}} \tag{CP1.19}$$

The exact same conversion procedure can be used to re-convert *whereabouts* back to *content*:

1. INVERT (the conversion factor)…. this gives $\sqrt{\frac{1}{h_{cp}G_{cp}}}$
2. MULTIPLY the result with Planck's constant 'h'…. this gives $\sqrt{\frac{h_{cp}}{G_{cp}}}$, which matches (CP1.14) and (CP1.15).

Applying this procedure to the *Crenel* gives:

$$C \xrightarrow{\text{Step 1}} \frac{1}{C} \xrightarrow{\text{Step 2}} \boxed{\frac{h}{C} = \mathrm{P}} \tag{CP1.20}$$

Note that the shaded areas in equations (CP1.19) and (CP1.20) are copies of equation (CP1.3) in which Planck's constant was defined: $\boldsymbol{h_{CP} \equiv 1\ C.P.}$

The equality between conversion and re-conversion procedure is remarkable because the failsafe mathematical approach to re-convert to the original is to undo each conversion step in reverse order. But in this case the above given conversion procedure works both ways. Thus, applying the conversion procedure twice results in the original result. This is regardless whether one starts with the *Package* or with the *Crenel*. Applying the conversion procedure twice therefore has the same impact as multiplication by a dimensionless 1. Because the procedure is universal, this reflects symmetry in nature at the very base level.

Also, we now have a deepest view on the conservation principle. This becomes obvious if we write equation (3.1) in reverse order:

$$\boldsymbol{C.P \equiv h_{CP}} \tag{CP1.21}$$

The above equation shows how an increase of *content* can be compensated by a decrease of *whereabouts*.

This exchangeability will be further addressed later.

2. Boltzmann.

Boltzmann's equation…

$$S = k_B . ln(w) \qquad (2.1)$$

…specifies the *entropy* '*S*' of a body.
'*w*' equals the number of statuses in which an object can reside.
'k_B' is Boltzmann's universal natural constant.

As the number of potential statuses *w* of a body rises, its *entropy* value will be higher, and the body appears more complex in its structure. Therefore, *entropy* and *complexity* are terms that go hand in hand.

In equation (2.1) the term *ln(w)* is dimensionless. Therefore entropy *S* and Boltzmann's constant k_B have the same *UoM*. In Metric Physics k_B can be expressed in various *UoM*, varying from macroscopic (such as *J/K* and *Hz/K*) to microscopic (such as *bit* and *nat*). The here relevant *UoM* for k_B are:

$k_{B(J/K)}=1.3806488 \times 10^{-23}$ *J/K*

$k_{B(Hz/K)}=2.0836618 \times 10^{10}$ *Hz/K*

$k_{B(bit)}=1.442695$ *bit*

$k_{B(nat)}=1$ *nat*(*)

(*): The *nat* is typically not shown as *UoM* because it is equal to dimensionless 1 (= unity). We will however continue to use the term *nat* to indicate that we refer to this particular version of k_B.

Nat and *bit* are mathematical, just like π. Therefore Boltzmann's constant k_B is not only universal: its numerical value is also shared between Metric Physics, *Crenel Physics* and any other system of *UoM*. This makes Boltzmann's constant unique in the arena of universal natural constants.

The number of statuses *w* is a discrete number. The concept of *angular* frequency is not consistent with this approach because the latter is associated with a (sinus shaped) wave. A wave shape isn't consistent with the above Boltzmann's equation, whereas its discrete frequency is: the frequency value tells us how often is flip-flopped between two discrete statuses, even though we don't know (or better: don't need to know because it's irrelevant here) what these two statuses exactly stand for.

Likewise, when we suggest that e.g. a photon can be represented by a sinus shaped wave, we don't know what is waving…

It is our objective to embed Boltzmann's theory into the *Crenel Physics* model. Because Boltzmann's universal natural constant is based on discrete statuses, we have a decisive argument for basing *Crenel Physics* on frequency, rather than on *angular* frequency.

To avoid confusion between the four listed versions of k_B, from here onwards any of these will be identified including their *UoM*. Thus we have $k_{B(J/K)}$, $k_{B(Hz/K)}$, $k_{B(bit)}$ and $k_{B(Nat)}$.

In all cases the same underlying physical fact is addressed. Therefore: $1 \equiv k_{B(nat)} \equiv k_{B(bit)} \equiv k_{B(Hz/K)} \equiv k_{B(J/K)}$. With k_B being dimensionless, the *UoM Hz/K* and *J/K* in which k_B can be expressed also must be dimensionless. Furthermore, there must be unambiguous universal relationships between the listed numerical values of all versions of k_B, or more specifically: between their respective *UoM*. Let's explore these relationships.

We start with the version of Boltzmann's constant whereby $k_{B(nat)}=1$. If we take a *bit*, recognizing that by its definition a *bit* can be in two different statuses, a series of n *bit* differentiates between 2^n different statuses. Equation (2.1) then becomes $S_{(nat)}=k_{B(nat)}.ln(2^n)=k_{B(nat)}.n.ln(2)$. Taking into account that $k_{B(nat)}=1$ we can simplify this to: $S_{(nat)}=n.ln(2)$. The term *ln(2)* in this equation is in recognition of *w* being equal to 2 when it comes to *bit*.

If we express k_B in *bit*, the factor *ln(2)* is embedded in the value of $k_{B(bit)}$. The above equation $S_{(nat)}=k_{B(nat)}.n.ln(2)$ then simplifies to $S_{(bit)} = k_{B(bit)}.n$. This explains why $k_{B(nat)}$ can be converted to $k_{B(bit)}$ by applying the conversion factor *1/ln(2)*. This conversion factor indeed equals the above listed value: $k_{B(bit)} = 1.442695041...$ *bit*, with as much accuracy as your calculator (or mathematical calculation algorithm) provides.

To explore the relationship between these two microscopic measures for entropy (*nat* and *bit*) at the one side, and their macroscopic counterparts (*J/K* and *Hz/K*) at the other, we first introduce a *UoM* for *temperature*. In general one *UoM* for *temperature* is defined as follows:

$$1\, UoM\ for\ Temperature = \frac{UoM\ for\ Energy}{k_B} \qquad (2.2)$$

To ensure dimensional integrity in the above equation, for k_B the *energy* version of Boltzmann's constant must be used, thus in Metric Physics $k_{B(J/K)}$. In Metric Physics *Energy* is expressed in *Joules*, and equation (2.2) then results in the *Kelvin* (symbol *K*) as *UoM* for temperature. Equation (2.2) is nothing but a circular reference between the *UoM* for *energy*, *temperature* and Boltzmann's constant k_B. In general: for any dimension of *content* there is an associated and unique version of

Boltzmann's constant. Thereby all versions will (or better: must) lead to one and the same measure for *temperature*.

For example we found *frequency* to be a measure for *content*. Therefore, we can alternatively define the *UoM* for temperature as:

$$1\ UoM\ for\ Temperature = \frac{UoM\ for\ Frequency}{k_B} \qquad (2.2a)$$

In such case, to ensure dimensional integrity, in Metric Physics the *Hz/K* version $k_{B(Hz/K)}$ is to be used.

Both scenarios must –as said- lead to the same measure for temperature (the *Kelvin*). This demands a universal relationship between the *UoM* for *energy* (*J*) and the *UoM* for *frequency* (*Hz*). That relationship is given by Planck's equation $E=h.\upsilon$. This explains why the conversion factor between $k_{B(J/K)}$ and $k_{B(Hz/K)}$ is given by Planck's constant '*h*', and is consistent with *h* being expressed in *J/Hz* or *J.s*.

The other way around is also valid: to any version of Boltzmann's constant we can associate a measure for *content,* which then all must lead to the same measure for *temperature*. We do not know how many versions of Boltzmann's constant could be provided by nature, but –given the above- it certainly would help if we knew them all.

For completeness we add the Metric Physics based equations for temperature based on the above listed *bit* and *nat* versions of k_B, thereby ensuring dimensional integrity.

For k_B= 1 *bit*:

$$1\ K = \frac{bit*K}{k_{B(bit)}} \qquad (2.2b)$$

And for k_B= 1 *nat*:

$$1\ K = \frac{nat*K}{k_{B(nat)}} \qquad (2.2c)$$

The added value of equations (2.2b) and (2.2c) is that the terms '*bit*K*' and the '*nat*K*' within these equations are additional *UoM* for *content*. We will address these two measures later in more detail.

In *Crenel Physics* the *Package* is the *UoM* for *energy*. Therefore equation (2.2) translates to:

$$1^0\ T_{CP} = \frac{Package}{k_B} \qquad (CP2.3)$$

By substituting equation (1.9) –the conversion from *Package* towards the Metric Physics '*Energy*' *UoM* - into above equation and by using the Metric Physics *J/K* version $k_{B(J/K)}$, we find the conversion factor from the *UoM* of T_{CP} towards Kelvin:

$$\mathbf{1^0 T_{CP}} = \sqrt{\frac{h.c^5}{G.(k_{B(J/K)})^2}} \quad Kelvin \qquad (2.4)$$

$$=3.5515\text{x}10^{32}\ K$$

This conversion factor is similar to the 'Planck temperature', albeit that –again, and for explained reason- equation (2.4) holds Planck's constant *h* instead of the 'reduced' version of this constant $\hbar$.

To convert $k_{B(nat)}$ towards $k_{B(Hz/K)}$ one divides:

- the *Crenel Physics* conversion factor from *Package* towards *Hz*
(per equation (1.11) equal to 7.4001x10^{42} *Hz*)

by:

- the conversion factor from *T* towards Kelvin
(per equation (2.4) equal to 3.5515x10^{32} *K*).

The result indeed equals the listed macroscopic value for $k_{B(Hz/K)}$:

$$1(nat) \equiv \frac{\sqrt{\frac{c^5}{h.G}}}{\sqrt{\frac{h.c^5}{G.(k_{B(J/K)})^2}}}$$

$$= \frac{7.4001\text{x}10^{42}\ Hz}{3.5515\text{x}10^{32}\ K} = 2.08366 \times 10^{10} = k_B(Hz/K) \qquad (2.5)$$

The *J/K* version $k_{B(J/K)}$ can be found likewise, or in a shortcut alternatively by multiplying the above *Hz/K* value by '*h*', based on Planck's equation: $E=h.\upsilon$.

The above indeed shows the anticipated universal relationships between afore listed *micro*scopic entropy *UoM* and *macro*scopic entropy *UoM*. 'Universal' because the relationships are based on universal natural constants only.

Based on these four *UoM*-options for k_B and thereby for *entropy S*, in Metric Physics we have an equal number of Boltzmann based routes towards *content*:

$$Content(J) \quad = T(K) \times S\left({}^{J}/_{K}\right) \qquad (2.6a)$$

$$Content(Hz) \quad = T(K) \times S\left({}^{Hz}/_{K}\right) \qquad (2.6b)$$

$$Content(bit.K) \quad = T(K) \times S(bit) \qquad (2.6c)$$

$$Content(nat.K) \quad = T(K) \times S(nat) \qquad (2.6d)$$

Thereby, the value of *temperature T(K)* is not to be confused with the macroscopic temperature of an ensemble of elementary particles. In above equations the temperature of an elementary particle such as e.g. a photon is at hand. A photon does not equalize its temperature when it is crossing a gas filled room: temperature is an embedded property of a photon.

The temperature *T(K)* in equations (2.6a,b,c,d) can be universally converted to *Hz* by reviewing the earlier found respective universal *UoM* for *temperature*, per equation (2.4):

$$1^0\, T = \sqrt{\frac{h.c^5}{G.(k_{B(J/K)})^2}}\ (Kelvin) \qquad (2.7)$$

… and the found universal *UoM* from *Package* to *Hz*, per equation (1.11):

$$1\, Package = \sqrt{\frac{c^5}{h.G}}\ (Hertz) \qquad (2.8)$$

Equations (2.7) and (2.8) show that if one multiplies the *UoM* for *temperature* with a universal constant equal to…

$$\frac{k_{B(J/K)}}{h} \qquad (2.9)$$

… the outcome is *Hz*.

Using this conversion factor we can universally assign a *temperature* to an object based on its *frequency*:

$$\frac{k_{B(J/K)}}{h} \times T = \upsilon \quad \text{or} \quad T = \frac{h}{k_{B(J/K)}} \times \upsilon \qquad (2.10)$$

Equation (2.10) gives us a method to determine an objects absolute (embedded) temperature *T(K)* by measuring its frequency. This *T(K)* can then be used in equations (2.6a,b,c,d). That's relevant, because we cannot measure such embedded temperature by using some 'thermometer'.

Using the conversion factor given by equation (2.9) we can 'reverse engineer' equation (2.6d) from its *UoM* in *nat.K* towards *nat.Hz*:

$$Content(nat.Hz) = \frac{k_{B(J/K)}}{h} \times T(K) \times S(nat) \qquad (2.11)$$

Because the *nat* is equal to unity (= dimensionless 1), equation (2.11) can be written as:

$$Content(Hz) = \frac{k_{B(J/K)}}{h} \times T(K) \times S(nat) \qquad (2.12)$$

If we apply equation (2.12) we can substitute for *T(K)* the value of *T* given by equation (2.10) and we thus find:

$$Content(Hz) = \upsilon \times S(nat) \qquad (2.13)$$

Content(Hz) can –in turn- be converted to *Content(J)* by multiplying it with Planck's constant. Thus equation (2.14) converts to:

$$Content(J) = h \times \upsilon \times S(nat) \qquad (2.14)$$

When we compare equation (2.14) to Planck's equation $Content(J) \equiv E = h \times \upsilon$ which is applicable to e.g. photons, we conclude that the entropy *S* of a photon (or of any other entity that is covered by Planck's equation) must equal 1*nat*:

$$S_{Photon} = 1\ (nat) \qquad (2.15)$$

As will be discussed later, this is an important finding, consistent with a photon's properties.

Equation (2.14) is a generalization of Planck's equation, applicable to objects of higher entropy values.

3. Observability: the entropy atom.

Physics is verified by the observable. For observing an object the minimum requirements are that…

1. …at least some minimum amount of *information* originating from the object…
2. …is transmitted towards some sensor…
3. …at which it changes the sensor's status.

Without any of these there can be no sensing, and thus be no observation.

This leaves two further options:

1. The object itself never changes status.
   Should this be the case, at one point in history our sensor might have picked up the object's status signal, changed its internal status accordingly (reflecting the 'sensing') and thereafter all further sensing stops. There would be no way to reconfirm that the source exists.
2. The object changes status at some interval.

In order to observe an object repeatedly (that is: over an extended period of time) the second option must apply.

Finally we require that our repeatedly status changing object can exist as such in an otherwise empty space. The conservation principle demands that any change is compensated. A compensation for any status change therefore must take place internally, since there is nothing else around. To facilitate that, it must have an entropy value of at least two *bits*. Thus, if one *bit* flips, the other can flop to compensate. We will name such two-bit object an *Entropy Atom*, for which we will use symbol *EA*.

> An *entropy atom* (*EA*) is the simplest repeatedly observable object. It has an entropy value of 2 *bits*.

Thereby '*atom'* reflects that anything of lower entropy cannot possibly be observed during some extended period of time (even though existing).

A photon does not meet all above requirements: we found that its entropy value is only 1 *nat*. We can however reconcile its past existence when it physically shares place and time with some sensor (read: physically hits it, thereby changing the status of our sensor and thereby disappearing from the scenery).

The above opens the door to other potential objects that might exist, but in no way could be observed remotely because their entropy is less than 2 *bits* or because they do not change status. 'Black matter' is a candidate. It might be composed of particles with an entropy value of 1 *bit*. In such hypothetical case we could nevertheless reconcile its existence, as we do for photons. 'Black matter' is something one –so far- never could observe, but that reveals its existence in that it induces a gravitational force. Such hypothesis would also explain why 'gravitational fields' travel at light velocity: even non-observable objects cannot travel faster that light.

Because at microscopic scale we can only observe *EA's* and nothing of lower entropy value, and because we base our physics on the observable only, we must recalibrate our microscopic equations for *content* accordingly: observable entities come in *EA's*, not in units of 1 *nat*.

The need for such recalibration becomes obvious when we evaluate Planck's equation $E = h.\upsilon$. The photon's entropy value was found to equal 1 *nat*. And the numerical value of h is based on that.

Being restricted to the observable we must use the enhanced version of Planck's equation (2.14):

$$Content(J) = h \times \upsilon \ \times S(nat) \qquad (3.1)$$

The *EA's* entropy value of *2-bit* is equal to:
2 bit = 2.ln(2) nat = ln(4) nat = ln(4).

Thus, the *content* of observable *EA's* per Planck's enhanced equation (3.1) equals:

$$Content(J) = h \times \upsilon \ \times \ln(4) \qquad \text{(for } EA\text{'s)} \qquad (3.2)$$

One might falsely argue that the conservation principle demands that if within an *entropy atom* one bit flips the other must flop simultaneously to compensate, and that therefore the entropy atom can only be in one of two possible statuses represented by '10' or '01'. However, if both bits are spatially separated, time will elapse between one bit flipping, and the arrival of that information to arrive at the other bit so that it will flop to compensate. During that elapsing time the intermediate statuses '00' or '11' of the entropy atom therefore will occur and can be observed from a remote position, so that indeed the entropy atom can be found in four different statuses.

Equations (2.6d) and (2.6e) as repeated below gave alternate Boltzmann based routes to find content:

$$Content(bit.K) \quad = T(K) \times S(bit) \qquad (3.3)$$
$$Content(nat.K) \quad = T(K) \times S(nat) \qquad (3.4)$$

Substituting for S(bit) the respective entropy values for an *EA* gives:

$$Content(bit.K) \quad = T(K) \times 2(bit) \qquad (3.5)$$
$$Content(nat.K) \quad = T(K) \times \ln(4) \qquad (3.6)$$

Because the *nat* equals dimensionless 1, we can simplify equation (3.6):

$$Content(K) \quad = T(K) \times \ln(4) \quad \text{(for } EA\text{'s)} \qquad (3.7)$$

In this equation we can substitute the *UoM* for *temperature* per equation (2.7). Thus, the *content UoM* for observable objects, expressed in *Packages* equals:

$$1\, Content\ UoM \ = \sqrt{\frac{h.c^5}{G.(k_{B(J/K)})^2}} \times \ln(4) \qquad (3.8)$$

Where the earlier found dimensions of the *Package* were *energy*, *mass* and *frequency* (see equations (CP1.14), (CP1.15) and (CP1.16)), equation (3.8) delivers an additional Boltzmann based *content* dimension. It can be described as a *bit* flow rate with a bandwidth of 2 *bits* (the entropy of an *EA*) at some frequency υ, or as an *Information Flow* for which we will use symbol *IF*.

The *Crenel Physics* version of equation (3.8) is:

$$1\, P = \sqrt{\frac{h_{CP}}{G_{CP}}} \times \frac{\ln(4)}{k_{B(\frac{energy}{temperature})}} \qquad (IF \text{ Units}) \qquad (CP3.9)$$

In this new *IF* dimension we thus can continue the usage of Planck's constant *h* as is, rather than correcting it for the higher entropy value objects. The factor $\frac{\ln(4)}{k_B}$ in equation (CP3.9) does correct for Planck's constant *h*, which is based on 1 *nat* objects, whereas the observable demands *entropy atoms*.

In equation (CP3.9) we kept using the *energy/temperature* version of k_B, as indicated. Although in *Crenel Physics* there would be no numerical difference between using the alternates *mass/temperature* or *frequency/temperature* versions of k_B (based on the *content* alternates *mass* or *frequency* for *energy*), this would not be so in alternative systems of *UoM* such as the Metric system. To support this broader context we have to show the applicable version of k_B here. It will be argued later, why equation (CP3.9) must hold in any system of *UoM*.

4. Conversion factors and *G*.

We identified 4 different dimensions for *content*:

1. *Energy*
2. *Mass*
3. *Frequency* for 1 *'nat'* objects
4. *Information Flow* (for observable objects, *EA's*)

Equations (1.9), (1.10) and (1.11) deliver the conversion factors relative to the *Package* of the first three of the above.

Equation (3.9) delivers the conversion factor for *Information Flow*, based on the observable *entropy atom*.

The four factors allow us to find the mutual conversions between the four listed dimensions of the *Package*, applicable to the observable world. E.g. to convert from the *UoM* for *Hz* (equal to $\sqrt{\frac{c^5}{h.G}}$ per equation (1.11)) towards the *UoM* for *IF* (equal to $\sqrt{\frac{h.c^5}{G.(k_{B}(^{J}/_{K}))^2}} \times \ln(4)$ per equation (3.8)) one must multiply with: $\frac{\ln(4).h}{k_{B}(^{J}/_{K})}$. The following figure shows all:

	J	kg	Hz	IF
J	J -> J 1	J -> kg $\frac{1}{c^2}$	J -> Hz $\frac{1}{h}$	J -> BR $\frac{ln(4)}{k_{B}(^{J}/_{K})}$
kg	kg -> J c^2	kg -> kg 1	kg -> Hz $\frac{c^2}{h}$	kg -> BR $\frac{ln(4).c^2}{k_{B}(^{J}/_{K})}$
Hz	Hz -> J h	Hz -> kg $\frac{h}{c^2}$	Hz -> Hz 1	Hz -> BR $\frac{ln(4).h}{k_{B}(^{J}/_{K})}$
IF	BR -> J $\frac{k_{B}(^{J}/_{K})}{ln(4)}$	BR -> kg $\frac{k_{B}(^{J}/_{K})}{ln(4).c^2}$	BR -> Hz $\frac{k_{B}(^{J}/_{K})}{ln(4).h}$	IT -> BR 1

Figure 4.1: overview of conversion factors between various *content* dimensions, based on *entropy atoms*.

Gravitational constant *G* does not appear in figure (4.1). Yet *G* does impact the length of the yardsticks in any of the four listed *content* dimensions: see equations (1.9), (1.10), (1.11) and (3.8). In all four of these, *G* appears as a factor: $\sqrt{^{1}/_{G}}$.

In the two *whereabouts* yardsticks (*time* and *distance*) the reciprocal thereof appears: $\sqrt{G}$, see equations (1.12) and (1.13).

Thus, gravitational constant *G* plays no role in any mutual conversion factor in neither the *content* arena, nor in the *whereabouts* arena. Therefore, the found factor $\sqrt{^{1}/_{G}}$ in all *content* yardsticks in combination with the found reciprocal thereof ($\sqrt{G}$) in all *whereabouts* yardsticks is consistent with the earlier finding that *Crenel* and *Package* are reciprocal to each other:

$$P.C \equiv h_{CP} \tag{4.1}$$

Such reciprocal relationship between *content* and *whereabouts* must be valid, otherwise the above listed consistent dependencies on *G* within all these yardsticks cannot hold. Note that equation (4.1) is a re-write of equation (CP1.3), in which Planck's constant was defined per *Crenel Physics*.

This finding has consequences for our observations. Let's therefore –for a moment- presume that the gravitational constant isn't really a constant, but that it –for some reason- may differ in its value.

To evaluate the anticipated impact we review gravitational orbiting.

The gravitational force F_g is:

$$F_g = G.\frac{M_1.M_2}{d^2} \tag{4.2}$$

The yardsticks for M_1, M_2 and *d* all depend on *G,* as described.

Substituting these dependencies, the gravitational force F_g is found proportional to:

$$G.\frac{\sqrt{^{1}/_{G}}\times\sqrt{^{1}/_{G}}}{(\sqrt{G})^2} = \frac{1}{G} \tag{4.3}$$

The centripetal force equals…

$$F_c = \frac{m.v^2}{r} \tag{4.4}$$

…and is proportional to:

$$\frac{\sqrt{^{1}/_{G}}\times\left(\frac{\sqrt{G}}{\sqrt{G}}\right)^2}{\sqrt{G}} = \frac{1}{G} \tag{4.5}$$

Because gravitational force and centripetal force are both found proportional to ${}^{1}/_{G}$, a hypothetical variation of G would have no impact on the stability of gravitational orbits.

We can also evaluate how the observed orbiting angular frequency *ω* depends on *G*. For that we enhance equation (4.4):

$$F_c = \frac{m.v^2}{r} = m.\omega^2.r \tag{4.6}$$

The term $\frac{m.v^2}{r}$ in the above is proportional to $\frac{1}{G}$ (see equation (4.5). The term $m.\omega^2.r$ is proportional to:

$$\sqrt{{}^{1}/_{G}}\ .\omega^2.\sqrt{G}\ \equiv\ \omega^2 \tag{4.7}$$

Thus, ω^2 is found proportional to $\frac{1}{G}$ and thereby ω is found proportional to: $\sqrt{{}^{1}/_{G}}$. This is of equal dependency as the *whereabouts* dimensions. Should the value of *G* increase, from an 'objective' viewpoint the orbiting angular frequency *ω* would therefore be found to decrease proportional to the factor $\sqrt{{}^{1}/_{G}}$, but the length of a *time UoM* would decrease by exactly the same factor. For this reason, on our local clock the number of time *UoM* to complete one orbit would not change.

In conclusion: where we observe stable gravitational orbits, this –as such- is no proof that the gravitational constant *G* indeed is a constant.

Based on the reciprocal relationship between *whereabouts* and *content* per equation (4.1), *content* is the consequence of a compression of *whereabouts*. They are like interconnected tanks. To compensate for the *whereabouts* compression associated with *content*, we can envision some sort of 'under-pressure' region in the *whereabouts* structure. It curves the local *whereabouts* gridlines, in some way compatible to 'isobaric lines' as seen on a weather map around a depression, which lines are directing winds (apart from major disturbances caused by the rotation of the earth). The *content* then resides at the exact centre of that depression. Thereby, a *whereabouts* 'under pressure' region not only equally impact all *spatial* dimensions within the *whereabouts* arena, but also and likewise the *time* dimension.

Because of the interconnection between *P* and *C* per equation (4.1) we lost the need for the Gravitational constant as a natural constant: gravity is a *consequence* of space conversion into *content*, rather than a cause of content. In the next chapter we will quantify this consequence.

5. <u>Various options for ***G***</u>.

<u>*A. forEntropy atoms:*</u>

In chapter 3 we found for observable objects (*Entropy Atoms*) the *Package* yardstick to equal (see equation (CP3.9)):

$$1\ P = \sqrt{\frac{h_{cp}}{G_{cp}}} \times \frac{\ln(4)}{k_B({}^{J}/_{K})} \qquad \textit{(IF UoM for EA's)} \tag{CP5.1}$$

Earlier we found both the *energy* and *mass* yardsticks per equations (CP1.14) and (CP.1.15) equal to:

$$1\ P = \sqrt{\frac{h_{cp}}{G_{cp}}} \qquad \textit{(In energy or mass UoM)} \tag{CP5.2}$$

We must demand all *content* yardsticks in any *content* dimension (*mass*, *energy*, and *IF* (for *EA's*) alike) to be of equal length. If not, this would violate the conservation principle: a conversion between dimensions would then lead to a different *content* value when expressed in *Packages.*

Equations (CP5.1) and (CP5.2) not being equal therefore –at first sight- might seem in conflict. However, this is not so if a universal relationship between the embedded natural constants h_{CP}, G_{CP} and k_B exists. This relationship can be found by multiplying two *content* yardsticks. Because each yardstick must equal 1 *P(ackage)*, a multiplication of two *content* yardsticks must equal 1 *P(ackage)*^{2}.

First we verify that the yardstick for *energy* and *mass* per equation (CP5.2) indeed equals 1 *Package*. This is confirmed by substituting the respective values for these constants: $h_{CP}=P.C$ (per equation (CP1.3)) and $G_{CP}=C/P$ (per equation (CP1.2)):

$$1\ P = \sqrt{\frac{h_{cp}}{G_{cp}}} = \sqrt{\frac{C.P}{{}^{C}/_{P}}} = \sqrt{P^2} = P \tag{CP5.3}$$

Thus, multiplying the yardstick for *energy* with the yardstick for *mass* indeed results in 1 *P(ackage)*^{2}.

We now demand that the yardstick for *IF* of *entropy atoms* per equation (CP5.1) also equals 1 *P(ackage)*. For that, we –consistently- demand that when we multiply (CP2.5) with the yardstick for either *energy* or *mass* alike (see equation (CP5.2)) the outcome also equals 1 *P(ackage)*^{2}:

$$\left\{\sqrt{\frac{h_{cp}}{G_{cp}}} \times \frac{\ln(4)}{k_B(J/K)}\right\} \times \left\{\sqrt{\frac{h_{cp}}{G_{cp}}}\right\} \equiv 1\ (Package^2) \qquad \text{(CP5.4)}$$

This equality can be rewritten as:

$$G_{CP} = \frac{h_{CP}}{k_B(J/K)} \times ln(4) \qquad \text{(for \textit{Entropy Atoms})} \qquad \text{(CP5.5)}$$

For verification we substitute this value for G_{CP} into equations (CP5.1):

$$\sqrt{\frac{h_{cp}}{G_{cp}}} \times \frac{\ln(4)}{k_B(J/K)} = \sqrt{\frac{h_{cp}}{\frac{h_{CP}}{k_B(J/K)} \times ln(4)}} \times \frac{\ln(4)}{k_B} = \sqrt{\frac{\ln(4)}{k_B(J/K)}}\ P \qquad \text{(CP5.6)}$$

and (CP5.2):

$$\sqrt{\frac{h_{cp}}{G_{cp}}} = \sqrt{\frac{h_{cp}}{\frac{h_{CP}}{k_B(J/K)} \times ln(4)}} = \sqrt{\frac{k_B(J/K)}{\ln(4)}}\ P \qquad \text{(CP5.7)}$$

The product of (CP5.6) and (CP5.7) indeed equals 1 P^2.

The terms *ln(4)* in the above equation (CP5.5) represents the entropy of the objects at hand (here *entropy atoms*), expressed in *nat*.

We can therefore adapt equation (CP5.5) to objects with other entropy values.

B. for 1 nat objects:

For 1 *nat* objects such as photons we find:

$$G_{CP} = \frac{h_{CP}}{k_B} \times ln(1) = 0 \qquad \text{(for 1 \textit{nat} objects)} \qquad \text{(CP5.8)}$$

Consequently, 1 *nat* objects such as photons are not subject to gravity: the applicable gravitational constant equals 0. Note thereby that gravitational lensing -as observed in space- therefore is not to be associated with a sideways acceleration of photons due to some gravitational force. Instead, space is curved, and photons sharply follow these curves.

We can further explore this by imagining an experiment in which we vertically shoot up a photon from the earth surface into space. It would be incorrect to assume that while climbing up, the photon loses energy because it has to climb and ultimately escape from the earth's gravitational pull. Such false assumption would be based on the incorrect presumption that the earth's gravity physically pulls at the photon. This envisioning is incorrect because –as we saw- photons are not impacted by gravitational force because their entropy is 1 *nat*.

So what is really happening, and how can we explain it using our *Crenel Physics* findings?
The explanation starts with considering the earth as *content*, thus as a 'compression' of *whereabouts*. Consequently, imaginary spatial gridlines around it show a compensating 'depression' relative to outer space: the gridlines near earth are further apart from each other, relative to gridlines in deep space. To verify this, let's make a yardstick in deep space, with an exact length of 1 meter. We confirm this length by measuring the time that it takes a photon to travel along it: 1/299792458 seconds (that's the exact definition of a meter). For that elapsed time measurement, we use two equal clocks. We now ship the yardstick and one of these clocks to the earth surface. Here, we will still find that our local clock measures 1/299792458 seconds for light to travel along the full yardstick's length, and that therefore our yardstick still has an exact length of one meter. Such consistent local observation is regardless where we would go, or how fast we would move.

After arrival on the earth surface we compare both clocks. We will find that the clock on earth runs slower relative to the clock that remained in deep space. Such time dilatation has been experimentally confirmed many times, whereby even height differences of less than one meter were enough to measure it.

Because on the slower earthly clock it still took 1/299792458 seconds to travel the length of our yardstick, our faster deep space clock will indicate (fractionally) more time between the start of the travel and the ending of it. Because light velocity is equal to all, the only conclusion is that from the remote perspective the yardstick on earth appears (slightly) stretched out. To ensure constant light velocity for all, the percentage of distance stretching thereby must exactly match the percentage of time dilatation. That spatial stretching equally applies to the spatial gridlines, which –from a remote perspective- seem further apart near earth. It is what we referred to as a spatial 'depression' around earth.

So let's now return to the photon that we vertically shot up from the earth surface. *Crenel Physics* says that gravitational force doesn't do a thing to it: its inherent properties remain as they are. Then what does happen? With the slower clock at the earth surface we measure the initial frequency of the photon. Upon arrival in deep space, we measure that frequency again. Thereby we will find a lower number, a drop in frequency. The reason thereof is however not that the photon itself was impacted and changed properties. The found frequency drop is entirely the outcome of our clock now running faster than it did before, while the photon remained as it was. Therefore, no gravitational force pulled at the photon, as it would pull e.g. a mass of 1 *kg*.

C. for 1 bit objects:

Between 1 *bit* objects (hypothetically existing, but not observable as individual objects) the gravitational constant equals:

$$G_{CP} = \frac{h_{CP}}{k_B} \times ln(2) \qquad \text{(for 1 } bit \text{ objects)} \qquad \text{(CP5.9)}$$

Because *ln(2)/ln(4)* = 0.5, the value of the gravitational constant between 1 *bit* objects is exactly 50% of the gravitational constant as found between *EA's* per equation (CP5.5).

D. for 3-bit objects:

In recognition that a 3-bit object can reside in 8 different states:

$$G_{CP} = \frac{h_{CP}}{k_B} \times ln(8) \qquad \text{(for 3-bit objects)} \qquad \text{(CP5.10)}$$

Because *ln(8)/ln(4)*=1.5, the value of the gravitational constant between 3-*bit* objects is exactly 150% of the gravitational constant as found between *EA's*.

E. for Higher entropy objects:

Between hypothetical 4-*bit* objects the gravitational constant is exactly twice the value as found between 2-*bit EA's*, because *ln(16)/ln(4)*=2. Thus, we see the value of the 'gravitational constant' grow proportionally to the entropy of the objects at hand. The entropy value embeds -what we would use to see as a gravitational force caused by the gravitational constant- instead as a property of *content,* and the gravitational equation then can be written as:

$$F_g = \frac{Content(1) \times Content(2)}{d^2} \qquad \text{(CP5.11)}$$

This demonstrates gravity to be an embedded consequence of *content*. Rather than being induced by *mass* along the *mass* dimension, it is induced by the product of *temperature* and *entropy*. Thereby, *temperature* is the embedded property of the elementary *entropy atoms* that the object is composed of, which is not to be confused with the macroscopic *temperature* of an ensemble thereof. The latter must likewise contribute to the gravitational force between objects. The *content* of an object consisting of an ensemble of n *entropy atoms* equals:

$$content = \sum_1^n [T_{embedded} \times \ln(4)] + T_{macroscopic}.S_{object} \qquad \text{(CP5.12)}$$

Thereby S_{object} must be expressed in *nat*, consistent with equation (2.6d).

6. Consequences of normalizing *c*.

The relationship between universal natural constants per equation (CP5.5)…

$$G_{CP} = \frac{h_{CP}}{k_B({}^J/_K)} \times ln(4) \qquad \text{(for } \textit{Entropy Atoms}\text{)} \qquad \text{(CP6.1)}$$

… is of fundamental conceptual importance. It is however based on the *Crenel Physics* model of *UoM*. The question to address here is, whether this relationship holds in any other system of *UoM*, such as Metric Physics.

In the *Crenel Physics* model light velocity *c* was normalized to a dimensionless 1. Consequently the differences between c, c^2, c^3 and c^5 all vanish since any power of *c* equals 1 if $c \equiv 1$. These higher powers of *c* appear in Einstein's equation $E = m.c^2$ as well as in the Metric Physics versions of the Planck units (see chapter 1). This normalization blurs physical realities in the *Crenel Physics* model. E.g. per Einstein's equation the difference between *mass* and *energy* vanishes because $c^2=1$ and thus $E=m$. Likewise did this blur the difference between *time* and *distance*. It is for this reason that the *Crenel Physics* model alone would not be likely to reveal such separate physical properties. However, in recognition that these properties do exist, these were embedded into the model as dimensions of *Package* and *Crenel*. Moreover: this led to yardsticks that are equivalents of the well-known Planck universal units of measurement.

If one evaluates the discussed natural constants within the Metric system, there is a reason to raise eyebrows. Their numerical values –at their roots- are based on rather arbitrary defined units of measurement. E.g. the meter once was defined as one ten-millionth of the length of the meridian through Paris from pole to the equator (source: Wikipedia). Later, in 1983, the meter was defined as: the length of the path travelled by light in vacuum during a time interval of 1/299792458 of a second. In doing so, *c* was thereby fixed to 299792458 m/s. It would be hard to communicate this procedure to Martians (so to speak). Much easier would it be, to communicate for distance the Planck length: $\sqrt{\frac{\hbar.G}{c^3}}$ (or the alternative *Crenel Physics* version thereof: $\sqrt{\frac{h.G}{c^3}}$). Once these Martians have figured out the values of their natural constants in whatever system of *UoM* they might have developed, they surely would come up with exactly the same length. As the *Crenel Physics* model did.

Within the Metric system, if one defines some standard procedure to define e.g. the *meter* as described, the numerical value of any universal natural constant that depends on the *meter* will depend on that definition. For example: the numerical value of light velocity *c* is in *m/s*, and would change proportional to the $meter^{-1}$. At bottom line, within the Metric system the numerical values of all natural constants depend on the definitions of *UoM* for a variety of different dimensions, and -as a glued group- are 'floating around'.

As said, normalizing *c* to a dimensionless 1 (as we did in *Crenel Physics*) indeed blurs e.g. the difference between *time* (*s*) and *distance* (*m*). Here, e.g. Planck's constant *h* in $m^2.kg/s$ can then be equally expressed in *m.kg* or *s.kg* or *s.J* etcetera (all these *UoM* would be equal because *time=distance* and *energy=mass*). But nevertheless, the respective universal natural constants *c* and *h* would still be measured in different *UoM*. The followed procedure to normalize one natural constant only (and no more than one), guarantees that any universal natural constant is still expressed in its own and unique *UoM*. Therefore, this restricted procedure cannot hide any universal natural constant. The fact that we could eliminate *G* therefore cannot be a consequence of the *Crenel Physics* normalization.

We conclude that the found fundamental relationship between natural constants per equation (CP6.1) must hold in any system of *UoM* that holds these constants. And that includes Metric physics.

7. Streamlined *UoM*.

This chapter recaptures our approach so far, thereby illustrating the consistency within the *Crenel Physics* model, which embeds –apart from a consistent factor $\sqrt{1/_{2.\pi}}$ - Planck's *UoM*.

Based on Einstein's $E = m.c^2$ we defined the *Package* as the shared *UoM* for the *content* dimensions *energy* and *mass*. The yardsticks thereof were expressed in universal natural constants, and showed resemblance with 'Planck mass' and 'Planck energy', see equations (1.9) and (1.10) respectively whereby the equations hold Planck's constant '*h*', whereas Planck's *UoM* hold the *reduced* Planck constant '*h/2.π*' (symbol '$\hbar$').

Based on Planck's $E = h.\upsilon$ we defined *frequency* as a third dimension of *content*. The yardstick thereof showed a likewise resemblance with the 'Planck frequency', see equation (1.11).

After introducing Boltzmann's equation $S = k_B.ln(w)$ we introduced a *temperature* scale similar to the 'Planck temperature', see equation (2.4). This scale is relevant because content was found to be the result of multiplying an objects embedded *temperature* with its *entropy*, see equations (2.6 a/d).

Entropy is dimensionless: it can be expressed in *nat* (= dimensionless 1). Therefore, any alternative option to express *entropy* (we addressed *bit*, *Hz/K* and *J/K*) also is dimensionless. This is due to the circular reference between the various options for Boltzmann's constant k_B and the definition of the *UoM* for temperature.

We found that Planck's equation $E = h.\upsilon$ is only valid for objects with an entropy value of 1 *nat*, such as photons. And that such low entropy objects cannot be observed while existing. For that, the minimum requirement is an entropy value of 2 *bits*, which defined the *entropy atom*. We enhanced Planck's equation to: $Content(J) = h \times \upsilon \times S(nat)$, see equation ((2.14), whereby *S(nat)*=1 for photons.

All above mentioned *content* dimensions are universally related to each other via their respective *UoM* because these are based on universal natural constants only.

To verify the relationships between the various *UoM*, let's explore the various dimensions in which we can express the *content* of an electron. Thereby we will temporarily ignore our requirement that its entropy should be at least 2 bits (because an electron is an observable object). Thus we will –falsely- presume that Planck's original equation $E = h.\upsilon$ applies.

In Wikipedia we can find the mass of an electron to equal 9.1094x10^{-31} *kg*. Because one *mass UoM* in *Crenel Physics* equals 5.4557x10^{-8} *kg* (see equation (1.10)), an electron therefore contains…

$\frac{9.1094\text{x}10^{-31} kg}{5.4557\text{x}10^{-8}\ kg} = 1.6697\text{x}10^{-23}$ …*Packages* along the *mass* dimension.

Per Einstein's equation $E = m.c^2$ we find the electron to contain 8.1871x10^{-14} *J* of *energy*. Because one *energy UoM* in *Crenel Physics* equals 4.9033x10^{9} *J* (see equation (1.9)), an electron therefore contains 1.6697x10^{-23} *Packages* along the *energy* dimension (= $\frac{8.1871\text{x}14^{-14} J}{1.6697\text{x}10^{-23} J}$). That numerical value is equal to the 1.6697x10^{-23} *Packages* as found along the *mass* dimension. The equality comes forth from the aforementioned Einstein equation, applied between Planck *mass* and Planck *energy*.

Per Planck's equation $E = h.\upsilon$ the electron's *content* can be represented by a *frequency* of 1.2356x10^{20} *Hz*. One *frequency UoM* in *Crenel Physics* equals 7.4001x10^{42} *Hz* (see equation (1.11)). An electron therefore again contains that same numerical value of $\frac{1.2356\text{x}10^{20}\ Hz}{7.4001\text{x}10^{42}\ Hz}$ =1.6697x10^{-23} *Packages*, this time along the *frequency* dimension. Again this is a logical outcome of the definitions of our *UoM*.

Perhaps less obvious is the embedding of our *temperature UoM*. Per equation (2.10): $T = \frac{h}{k_{B(J/_K)}} \times \upsilon$ we can convert an electron's *frequency* into *temperature*. This gives a value of 5.9299x10^{9} K. Because one *temperature UoM* in *Crenel Physics* equals 3.5515x10^{32} *K* (see equation (2.4), an electron therefore contains 1.6697x10^{-23} *Packages* along the *temperature* dimension. And again this numerical value is equal to the value found for in the other *content* dimensions.

In conclusion: we can express the *content* of an electron along the *mass*, *energy*, *frequency* or *temperature* dimension alike: in all cases the numerical value equals 1.6697x10^{-23} *Packages*.

> If instead of the lookalike Planck *UoM* as found in *Crenel Physics*, we use the actual Planck's *UoM*, along all of these 4 *content* dimensions we would also and likewise have found an equal numerical value along each of the aforementioned dimensions. In such case this numerical value would have been 4.1853x10^{-23} , the difference is a factor $\sqrt{1/_{2\pi}}$.

The relationship between the various *Package UoM* therefore is obvious now: if we express *content* in *Packages*, for 1 *nat* objects it is irrelevant to specify what dimension of the *Package* we thereby refer to (*mass, energy, frequency* or *temperature*): the numerical value is the same for all these cases. This is so within the *Crenel Physics* system of *UoM*, but likewise so within any system of *UoM* that is based on Planck's natural units of measurement.

Based on the conservation principle this numerical equality must also apply to objects with an entropy value that is not equal to 1 *nat*. It was this requirement that –for *entropy atoms*- ultimately demanded a relationship between universal natural constants per equation (CP5.5):

$$G_{CP} = \frac{h_{CP}}{k_B(\frac{Energy}{Temperature})} \times ln(4) \qquad \text{(for } EA\text{'s)} \qquad \text{(CP7.1)}$$

8. Verification and discussion.

In chapter 6 we concluded that equation (CP5.5) must hold in any system of *UoM*, including *Metric Physics*. Thus we generalized this equation to:

$$G = \frac{h}{k_B(^{Energy}/_{Temperature})} \times ln(4) \qquad (8.1)$$

Substituting the Metric Physics values for h (=6.62607x10^{-34} J.s) and k_B (=1.38065x 10^{-23} *J/K*), and ln(4) =1.38629 into this equation gives a calculated value for G between *entropy atoms*:

$$G = \frac{6.62607\times10^{-34}}{1.38065\times10^{-23}} \times 1.38629 = 6.6531 \times 10^{-11} \qquad (8.2)$$

The 2014 CODATA-recommended value of the gravitational constant is:
6.67408(31) x 10^{-11} Nm^2kg^{-2} (or $m^3kg^{-1}s^{-2}$)
Thus, equation (CP8.1) –applicable between *entropy atoms*- undershoots this literature value for G by about 0.3%.

The explanation for the difference is found in that we based the gravitational constant on the interaction between *entropy atoms*, whereas even a single atom is a group or ensemble thereof. Consistent with equation (2.6d) we based the gravitational force on *content* calculated as:

$$content = \sum_1^n [T_{embedded} \times \ln(4)] \qquad \text{(CP8.3)}$$

Whereas per equation (CP5.12)…

$$content = \sum_1^n [T_{embedded} \times \ln(4)] + T_{macroscopic}.S_{object} \qquad \text{(CP8.4)}$$

…we must add a macroscopic term to reflect the extra boost in content that is associated with the macroscopic temperature property. This extra boost will then be reflected in finding a higher value for the gravitational constant G.

> There is an analogue macroscopic impact in Einstein's equation, not covered by it. Per $E = m.c^2$ we can calculate how much energy we can withdraw from a certain mass m. The equation does however not include the impact of the macroscopic temperature of that mass. It is obvious that should that mass be hot, it –in total- can be converted into more energy that if it is cold. Here, the difference is extremely marginal because c^2 is a very large number, and therefore the macroscopic thermal energy can be neglected in practical cases.

When –in *Crenel Physics*- it comes to finding the *content* of an object (so that we can apply the gravitational equation) we need a likewise correction term based on the macroscopic temperature and entropy of the object, as reflected in equation (CP8.4).

> In this case however there is no –large- factor c^2 to deal with. Therefore relatively larger corrections might be anticipated.

In Wikipedia…
(see **https://en.wikipedia.org/wiki/Gravitational_constant**)
…it can be found that various actual measurements of the gravitational constant are not only difficult to execute, but also mutually exclusive. E.g. an 'improved cold atom' measurement by Rosi et al., published in 2014, is referred to. This reference reports *G* to be equal to 6.67191(99) x 10^{-11} Nm^2kg^{-2}. This is approximately 0.03% below the more commonly accepted value of 6.67408(31) x 10^{-11}. The lower found value of *G* (measured at low temperature and at atomic scale) is directionally in line with the here presented *Crenel Physics* model in which an 'entropy atom ensemble temperature' supposedly boosts the gravitational force with an additional 0.3%. This is about 10 times more than found by Rosi et al.

To find potential mechanisms for such larger boost, we must review the structure of matter.

Per standard model three quarks jointly compose a proton or neutron. Quarks are known to have a series of properties that distinguishes them from each other, as well as from other elementary particles in the standard model. Some of the known quark properties are: total angular momentum, baryon number, electric charge, isospin and charm. One *entropy atom* could not possibly have different properties relative to the other. Quarks therefore must be more complex than *entropy atoms*. Mathematically it therefore must take a combination of a yet unknown number of *entropy atoms* to shape quarks. Their related grouping -while shaping quarks- would thereby likely be subject to rules or patterns, as we know electrons group in patterns within an atom. And likewise, such grouping could then be the basis for the various properties.

Within the construction of content we can distinguish several discrete scales of construction levels. The following figure shows these, including what we know now so far about the gravitational constant's value and *content*:

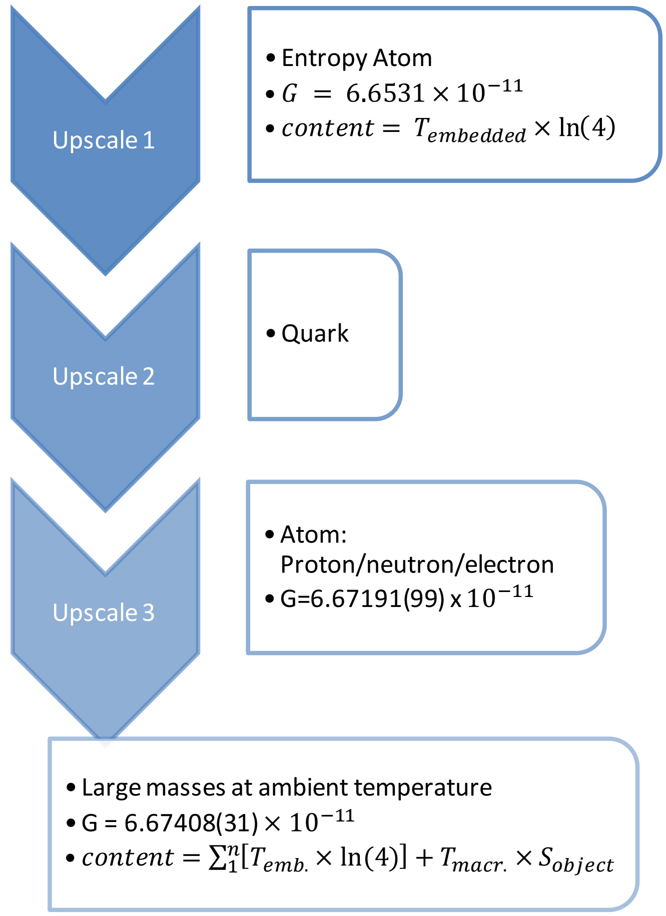

Figure 8.1: various scales of *content*.