The Mass Gap, Kg and the Planck Constant The Planck Constant Is a Composite Constant One kg Is 85224655043574 8 × 10^{36} collisions per second The Mass Gap Is 1.1734 × 10^{-51} kg and also m_p

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Abstract

In this paper we discuss and calculate the mass gap. Based on the mass gap we are redefining what a kilogram likely truly represents. This enables us to redefine the Planck constant into what we consider to be more fundamental units. Part of the analysis is based on recent developments in mathematical atomism. Haug [1, 2] has shown that all of Einstein's special relativity mathematical end results [3] can be derived from two postulates in atomism. However, atomism gives some additional boundary conditions and removes a series of infinite challenges in physics in a very simple and logical way.

While the mass gap in quantum field theory is an unsolved mystery, under atomism we have an easily defined, discrete and "exact" mass gap. The minimum rest mass that exists above zero is 1.1734×10^{-51} kg, assuming the observational time window of one second. Under our theory it seems meaningless to talk about a mass gap without also talking about the observational time-window. The mass gap in one Planck second is the Planck mass. Further, the mass gap of just 1.1734×10^{-51} kg has a relativistic mass equal to the Planck mass. The very fundamental particle that makes up all mass and energy has a rest-mass of 1.1734×10^{-51} kg. This is also equivalent to a Planck mass that last for one Planck second.

We are not trying to solve the Millennium mass gap problem in terms of the Yang-Mills theory. We think the world is better understood by atomism and its recent mathematical framework. If there also could be a possible link between these tow theories we leave up to others to find out.

Keywords: Composite constant, kg, mass gap, Planck mass, relativistic mass, atomism, particle frequency.

1 Introduction

The Planck constant was introduced by Max Planck [4] in 1900. The Planck constant is linked to the idea that energy comes in quanta and plays a central role in all of quantum mechanics. The Planck constant is one of the fundamental constants that have been most accurately measured, in contrast to Newton's gravitational constant G, for example, where there still is considerable uncertainty in what its "exact" value should be. See [5, 6, 7], for example. Recent research related to the Watt balance also makes the Planck constant very central in relation to possibly redefining the kilogram, see for example [8]. In this paper we suggest that the Planck constant is a composite constant and that by breaking it down into what it truly represents we are able to better understand the Planck constant. This in turn helps us to understand the mass gap and also to redefine the Planck constant, find its exact value, and extending that finding to redefine a kg with an exact value.

Any fundamental particle mass can be written as

$$m = \frac{\hbar}{\bar{\lambda}} \frac{1}{c} \tag{1}$$

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where $\hbar$ is the reduced Planck constant, $\bar{\lambda}$ is the reduced Compton wavelength of the particle in question, and c is the speed of light[1] The output unit is then in units of kg. The speed of light is simply the distance light travelled for a given time period. The speed of light is typically given in meters per second. We all know roughly what a meter is and what a second is; they are something we can all relate to. Further, the reduced Compton wavelength is a length, again we can relate to a length. On the other hand, the reduced Planck constant $\hbar$ in terms of SI units is given as kg$\cdot m^2/s$. I think few if any of us can relate to what this represents exactly, kg times meters squared per second. What kind of exotic animal is that? This complex notation alone seems to give a hint that the Planck constant is a composite constant that we can break down in far simpler and more intuitive fundamental constants.

2 The Mass Gap and the Kg

We will assume that at the very depth of reality there only exists one type of fundamental particles, namely indivisible particles, always moving at the speed of light; see [1, 2]. In this model we will have a binary system of energy and matter. We have matter with rest-mass when two indivisible particles collide, and we can call the indivisible particles energy when they not are colliding. We assume these indivisible particles always move at the speed of light. An exception is in the very collision point when two indivisible particle counter-strike (collide) and changes their direction of movement. We will claim a single collision between two indivisible particles is equal to a mass of 1.1734×10^{-51} kg, if the observational period is one second. This is what we will call the mass gap. This is the minimum mass we can observe within a second; in other words, the mass gap within a second. If we look away from units for a moment this is the same value as given by the reduced Planck constant divided by c^2:

$$\frac{\hbar}{c^2} \approx 1.1734 \times 10^{-51} \tag{2}$$

The units here are not in kg, something we soon will get back to.

Under atomism any known subatomic particle is rapidly fluctuating between mass (the mass gap) and 'internal' energy. Based on atomism (see [1, 2]) mass is simply counter-strikes between indivisible particles. When two indivisible particles counter-strike (collide), we define this as mass, and when they do not counter-strike, they are internal energy. An electron, for example, can simply be thought of as two indivisible particles traveling back and forth, each over a distance equal to the reduced Compton wavelength of the electron. Based on this scenario, an electron has the following number of internal counter-strikes per second

$$\frac{c}{\bar{\lambda}_e} \approx 7.76344 \times 10^{20} \text{ counter-strikes per second} \tag{3}$$

The electron is rapidly fluctuating between energy and mass 7.76344×10^{20} times per second. At each counter-strike we have a mass of 1.1734×10^{-51} kg. That is to say the total rest-mass of an electron is

$$m_e = \frac{c}{\bar{\lambda}_e} m_g = \frac{c}{\bar{\lambda}_e} \times 1.1734 \times 10^{-51} \approx 9.1094 \times 10^{-31} \tag{4}$$

where m_g is the mass gap. The mass gap 1.1734×10^{-51} kg is interestingly also equal to the mass of one Planck mass for one Planck second. Looking away from units for a moment and we have

$$m_g = \frac{\hbar}{c^2} = m_p t_p \approx 1.1734 \times 10^{-51} \tag{5}$$

However, $\frac{\hbar}{c^2}$ is not the notation of kg, but rather kg$\cdot s$. In our atomist model if we have a time window of one second then the maximum reduced Compton wavelength we can have in a mass to not reach zero mass is

$$\bar{\lambda}_g = \frac{\hbar}{m_g c} = 299792458 \text{ m} \tag{6}$$

where m_g is the mass in kg of the mass gap. We suggest that there is a very important reduced Compton wavelength equal to the distance light travels in one second (when we operate with the speed of light in terms

[1] More precisely the round-trip speed of light, or the one-way speed of light as measured with Einstein-Poincaré synchronized clocks.

of meters per second). The reduced Compton wavelength with distance equal to the distance the light travels in per time unit chosen is conceptually important, as it is linked to the mass gap, in our view. Solved with respect to the mass gap, m_g, we get

$$m_g = \frac{\hbar}{\bar{\lambda}_g}\frac{1}{c} = \frac{\hbar}{299792458}\frac{1}{c} \approx 1.17337 \times 10^{-51} \text{ kg} \tag{7}$$

This is equal in value to $\frac{\hbar}{cc}$, but one of the c's is actually the reduced Compton wavelength, and now the output of the mass gap is in kg. This can be used to better understand what one kg truly represents at a deeper level. If one counter-strike is equal to the mass gap, then one kg must be equal to the following number of counter-strikes per second

$$\text{One } kg \text{ in terms of number of counter-strikes} = \frac{1}{m_g} = \frac{1}{1.17337 \times 10^{-51}} \approx 8.52247 \times 10^{50} \tag{8}$$

This shows that one kg is an enormous amount of counter-strikes between indivisible particles per second. One kg is related to 8.52247×10^{50} counter-strikes between indivisible particles per second. Based on this observation, we can also better understand the relationship between kg and fundamental particles such as electrons. The electron is counter-striking $\frac{c}{\bar{\lambda}_e} = 7.76344 \times 10^{20}$ times per second. As a fraction of the number of counter-strikes in one kg we find that an electron mass is

$$m_e = \frac{7.76344 \times 10^{20}}{8.52247 \times 10^{50}} = 9.10938 \times 10^{-31} \text{ fraction of the number of counter-strikes in one kg} \tag{9}$$

Any mass in kg is simply a fraction of the number of counter-strikes that exist in a kg. Further, based on this, the reduced Planck constant is simply

$$\hbar = \frac{c^2}{8.52247 \times 10^{50}} \tag{10}$$

And any fundamental particle, as a fraction of the number of counter-strikes in one kg, is given by

$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c} \approx \frac{\frac{c^2}{8.52247 \times 10^{50}}}{\bar{\lambda}}\frac{1}{c} = \frac{c}{\bar{\lambda}}\frac{1}{8.52247 \times 10^{50}} \tag{11}$$

That is any type of fundamental particle is simply the internal frequency of counter-strikes per second multiplied by the mass gap. The mass gap in terms of the fraction of kg counter-strikes is

$$m_g = \frac{1}{8.52247 \times 10^{50}} \approx 1.17337 \times 10^{-51} \text{ fraction of the number of counter-strikes in one kg} \tag{12}$$

3 The Mass Gap as a Function of the Observational Period

It is important to understand that if we observed a point different than one second the mass gap could be smaller or larger than 1.17337×10^{-51} kg. If we use an observational time window shorter than one second the mass gap will be larger than this, and if the observational time window is larger than one second then the mass gap will be smaller than this. For a two-second period the mass gap is $\frac{m_g}{2}$ and for a three-second observation period the mass gap is $\frac{m_g}{3}$. The mass gap is simply one-counter-strike, but to talk about the mass in terms of kg we must compare one counter-strike with the number of counter-strikes in a kg during the same time period. And per our definition, one kg will be approximately 8.52247×10^{50} counter-strikes per second and naturally $2 \times 8.52247 \times 10^{50}$ per two seconds. One kg is always one kg, but the mass gap changes with the time window. Hypothetically, the shortest time window that is likely possible is one Planck second. In one Planck second, one kg is approximately 45945119.23 counter-strikes. And the mass gap is always one counter-strike, and one counter-strike as a fraction of the number of counter-strikes in one Planck second for a kg is

$$m_g = \frac{1}{45945119.23} \approx 2.17651 \times 10^{-8} = m_p \tag{13}$$

That is to say, the mass gap is one Planck mass for one Planck second. This is consistent with Haug's atomist model for anything with rest-mass, where he has claimed all known subatomic particles consist of Planck masses that last for one Planck second and this cycle is repeated many times per second based on the subatomic particle frequency. This also means that any mass with a mass larger than the mass gap (as measured in one Planck second) cannot be one single fundamental particle, but must consist of two or more fundamental particles. In this view, one fundamental particle most likely consists of two indivisible particles. However, there could be some modifications here without altering the main concept of our theory.

This does not mean that one kg has a lower mass the shorter the time period over which we measure. Using kg is simply making use of a standardized reference for a given amount of matter. If we observed the number of counter-strikes in one kg over half a second, then the number of counter-strikes in that kg would be $\frac{1}{2} \times 8.52247 \times 10^{50}$. Accordingly, the number of counter-strikes in any known subatomic particle would also be reduced in half compared to what they achieve in one second. The relative mass is "invariant" to what time frame we look at. However, the mass gap will vary for different time windows. This is because the mass gap always is only one counter-strike.

4 Frequency Summary

The table summarize how mass for any subatomic particle or even composite matter can be described as a number of counter-strikes per second. One kg is the enormous amount of 8.52247×10^{50} counter-strikes per second and for any subatomic mass, if we want to convert it to kg, we can find the value by dividing the subatomic particle frequency with the number of counter-strikes that represent one kg.

	Mass as frequency **Counter-strikes per second**	**Mass as kg** **"frequency ratio"**
Mass gap for one second	$m_g = 1$ [a]	$m_g = \frac{1}{8.52247\times10^{50}} \approx 1.1734 \times 10^{-51}$ kg
Electron	$m_e = \frac{c}{\bar{\lambda}_e} \approx 7.76344 \times 10^{20}$	$m_e = \frac{7.76344\times10^{20}}{8.52247\times10^{50}} \approx 9.10938 \times 10^{-31}$ kg
Meson	$m_m = \frac{c}{\bar{\lambda}_m} \approx 2.04949 \times 10^{23}$	$m_m = \frac{2.04949\times10^{23}}{8.52247\times10^{50}} \approx 2.40481 \times 10^{-28}$ kg
Muon	$m_M = \frac{c}{\bar{\lambda}_M} \approx 1.60523 \times 10^{23}$	$m_M = \frac{1.60523\times10^{23}}{8.52247\times10^{50}} \approx 1.88353 \times 10^{-28}$ kg
Planck mass	$m_p = \frac{c}{l_p} \approx 1.85492 \times 10^{43}$	$m_p = \frac{1.85492\times10^{43}}{8.52247\times10^{50}} \approx 2.17651 \times 10^{-8}$ kg
Proton mass	$m_P = \frac{c}{\bar{\lambda}_P} \approx 1.42549 \times 10^{24}$	$m_P = \frac{1.42549\times10^{24}}{8.52247\times10^{50}} \approx 1.67262 \times 10^{-27}$ kg
One kg	8.52247×10^{50}	$\frac{8.52247\times10^{50}}{8.52247\times10^{50}} = 1$ kg
One kg	45945119.23 (per Planck second)	$\frac{5945119.23}{5945119.23} = 1$ kg
Mass gap for one Planck second	$m_g = 1$ [b]	$m_g = \frac{1}{45945119.23} \approx 2.17651 \times 10^{-08}$ kg

Table 1: The table shows how subatomic particle masses can be expressed as "Clock" frequencies and that kg simply can be seen as a standardized frequency ratio.

[a] The mass gap could be less than one counter-strikes per second, the mass gap is 1 counter-strike per any time window we choose to measure. This simply means the minimum mass above zero simply is one counter-strike between two indivisible particles.

[b] The mass gap could be less than one counter-strikes per second, the mass gap is 1 counter-strike per any time window we choose to measure. This simply means the minimum mass above zero simply is one counter-strike between two indivisible particles.

5 The Reduced Planck Constant and Kg Exactly Defined

By defining a kg as an integer number of counter-strikes per second we can get an exactly defined kg measure and also an exactly defined Planck constant. We could define one kg as an exact number of counter-strikes, for example

$$\text{One kg in terms of counter-strikes per second} = 8.52246550435748 \times 10^{50} \tag{14}$$

We could call $852246550435748 \times 10^{36}$ the one kg constant. The re-defined reduced Planck constant would then be defined as exactly

$$\hbar = \frac{c^2}{852246550435748 \times 10^{36}} = \frac{299792458^2}{852246550435748 \times 10^{36}} \tag{15}$$

6 Two Faces of the Mass Gap

Haug [2, 9, 10, 11] has recently introduced a new maximum velocity for subatomic particles (anything with rest mass) that is just below the speed of light given by

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{16}$$

where $\bar{\lambda}$ is the reduced Compton wavelength of the particle we are trying to accelerate and l_p is the Planck length, [12]. To observe a photon we claim the photon has to interact with something. If we want to observe a single photon within one second, then we will claim we need a collision between two photons (that is two indivisible particles). This means the two indivisible particles moving towards each other can be seen as a mass with reduced Compton wavelength equal to $\bar{\lambda}_g$ if they have one collision within one second. And only if the collision can be observed, it is the mass gap. This means the maximum velocity of two photons that we actually observe within one second is

$$\begin{aligned} v_{max,g} &= c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}_g^2}} \\ &\approx c \times 0.99999999999999999999999999999999999999 \\ &\quad 999999999999999999999999999999999999999999999999855 \end{aligned} \tag{17}$$

That it is slightly below c and has to do with the fact that the two photons collided. Interestingly, the relativistic mass of the mass gap is the Planck mass

$$m_p = \frac{m_g}{\sqrt{1 - \frac{v_{max,g}^2}{c^2}}} = m_g \frac{\bar{\lambda}_g}{l_p} = \frac{\hbar}{\bar{\lambda}_g} \frac{1}{c} \frac{\bar{\lambda}_g}{l_p} = \frac{\hbar}{l_p} \frac{1}{c} \tag{18}$$

This naturally also means that the rest mass of a Planck mass particle (which is equal in value to the Planck mass times the Planck time) is

$$m_g = m_p \sqrt{1 - \frac{v_{max,g}^2}{c^2}} \tag{19}$$

If we observe one photon to photon collision in one second, then each indivisible particle (photon) has a relativistic mass equal to half of the Planck mass. At the very instant when two light particles collide we can consider the velocity to be zero. Even if a single indivisible particle has a relativistic mass equal to half of the Planck mass, its rest-mass is just equal to half of the mass gap. However, the mass gap always consists of two indivisible particles colliding and is m_p if observed in one Planck second and 1.17337×10^{-51} kg if it is observed in a different time window.

This is a somewhat unconventional way of thinking, but as Haug has shown, the maximum velocity for anything with rest-mass

7 Summary

We have suggested that the mass gap is 1.17337×10^{-51} kg per second observational period or $\frac{1}{852246550435748 \times 10^{36}}$ fraction of the number of counter-strikes of one kg. In the atomism model, the mass gap is one single counter-strike between two indivisible particles. The mass gap can also conceptually be seen as a subatomic particle with a reduced Compton wavelength equal to the distance light travels in one second if we are interested in the mass gap for a one-second time period.

Further, based on this perspective, one kg of mass can be redefined as $852246550435748 \times 10^{36}$ counter-strikes between indivisible particles per second. This leads us to a redefinition of the reduced Planck constant, which can be represented as $\hbar = \frac{c^2}{8.52246550435748 \times 10^{50}}$. And every type of fundamental particle can be represented as a fraction of the number of counter-strikes in one kg. That is to say, any mass is given as a particle frequency divided by the number of counter-strikes in one kg.

$$m = \frac{c}{\bar{\lambda}} \frac{1}{852246550435748 \times 10^{36}} \text{ counter-strike fraction of one kg} \quad (20)$$

Further, the mass gap for one Planck second is one Planck mass. One kg has approximately 45945119.23 counter-strikes per Planck second. And this means the minimum mass one can observe in one Planck second as a fraction of the counter-strikes in one kg is $\approx \frac{1}{45945119.23} \approx 2.17651 \times 10^{-08}$.

We think that our theory could be useful for deciding on an exact definition of the kilogram and thereby also the Planck constant. The speed of light is already exactly defined, so is one meter, and here the Planck constant and the kilogram could be as well. The uncertainty in many measurements would then lie in how long a second is. More importantly, if one studies Haugs full theory on atomism, then one may see that many of the mysteries in physicists can be reduced to very simple logic. It is clear that the Planck constant and the gravitational constant are composite constants. When decomposing these constants into what they likely truly represent we are able to develop very simple and logical explanations for mass, energy, time, and much more. I encourage seekers of knowledge to read my full theory on atomism :-)

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