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# Cosmological Scale Versus Planck Scale: As Above, So Below!

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## Abstract

We will demonstrate that the mass (equivalent mass) of the observable universe divided by the universe radius is exactly identical to the Planck mass divided by the Planck length. This only holds true in the Haug universe model that takes into account Lorentz's relativistic mass, while in the Friedmann model of the universe the critical mass of the universe divided by the Hubble radius is exactly equal to  $\frac{1}{2} \frac{m_p}{l_p}$ . Further in the Haug model of the universe the mass of the universe divided by the radius of the universe is exactly identical to  $\frac{m_p}{l_p}$ , that is the Planck mass divided by the Planck length. This is much more than just a speculative approximation, for the findings are consistent with a new unified quantum gravity theory that links the cosmological scale directly to the Planck scale.

**Key Words:** universe mass (energy), Hubble radius, Hubble constant, Hubble surface, Planck length, Planck mass, Planck time.

## 1 Is there a relation between the cosmological scale and the Planck scale? A historical perspective

“*As above, so below*” is a saying from the ancient philosopher Hermes Trismegistus in a text known as the *Emerald Tablet*, as the original version was supposedly found on an emerald tablet, though the veracity of this is unclear. The saying reflects a philosophical idea holding that the smallest scales of the world were reflected in the largest scales of the cosmos, and the opposite. For example, Isaac Newton was clearly so fascinated by some of the work of Hermes Trismegistus that he even made his own translation of the *Emerald Tablet*; see, for example, Newman [1] and Chambers [2]. Today we know much more about the cosmos and more about the smallest possible length of the universe, the Planck length. However, little progress has been made on the Planck scale in relation to gravity for more than 100 years. Only recently has one been able to measure the Planck length indirectly without any knowledge of  $G$ ,  $\hbar$ , or even  $c$ ; see [3, 4]. We will here demonstrate that Trismegistus was actually right in his conjecture, for there is a direct link between the largest (observable) scales of the cosmos and the Planck scale.

A series of authors (including myself) have previously, and somewhat more speculatively, suggested there are likely potential relationships between the cosmological scale and the Planck scale; see Haug [5] and Bhatt and Becker [6]. Actually, already in 1916, Einstein [7] suggested the next step in gravity theory would be to make a quantum gravity theory, something he tried to do for the rest of his life, but with little success. In 1918, Eddington [8] suggested that a new quantum gravity theory would likely be closely linked to the Planck length. Today, most physicists trying to develop a quantum gravity theory that can be unified with quantum mechanics assume the Planck scale will play an important role; see, for example, [9–11]. Quantum cosmology has garnered increased interest [12]. As general relativity theory combined with observations has been our main tool in also understanding the cosmological scales, one will expect that a quantum gravity theory similarly will also be able to explain the cosmological scale. Recently, a new quantum gravity theory has been published that claims to unify gravity with quantum mechanics; this is the so-called collision-space time; see [13–15]. This theory has further been linked to the cosmological scales [16].

An important recent step is that we [17] have shown one can extract the Planck length from cosmological observations with no prior knowledge of  $G$  or  $\hbar$  and that cosmological observable phenomena can then again be predicted only from two constants, namely the Planck length and the speed of light (the speed of gravity), in addition to variables. This can basically be seen almost as proof that the Planck scale is directly related to the cosmological scale. It is more than speculation; it is testable and verifiable.

## 2 When working with kilogram mass

In the Haug [15, 18] model of the universe, the standard universe mass in kilograms is given by:

$$M_u = \frac{c^3}{H_0 G} \quad (1)$$

Further, we can solve the Max Planck [19, 20] length formula,  $l_p = \sqrt{\frac{G\hbar}{c^3}}$ , with respect to  $G$  we get  $G = \frac{l_p^2 c^3}{\hbar}$ ; see [21–23].

Next we solve the reduced Compton [24] wavelength formula,  $\bar{\lambda} = \frac{\hbar}{Mc}$  with respect to  $M$ , and this gives  $M = \frac{\hbar}{\bar{\lambda} c}$ . Some will likely already here protest and claim we not can do this for a macroscopic mass as we will do and only for subatomic particles like the electron. This we have demonstrated not is the case, and that this way of expressing the mass can be used for any object, see [3, 4]. Now replace  $G$  and  $M_u$  with these expressions and solve with respect to  $H_0$ , and this gives:

$$H_0 = \frac{c\bar{\lambda}_u}{l_p^2} \quad (2)$$

We use subscript  $u$  on the reduced Compton wavelength here just because we got it from the universe mass  $M_u$ . The Hubble radius in the Haug universe is given by:

$$R_H = \frac{c}{H_0} = \frac{l_p^2}{\bar{\lambda}_u} \quad (3)$$

Next, the Haug universe mass divided by this radius gives:

$$\frac{M_u}{R_H} = \frac{\frac{\hbar}{\bar{\lambda}_u} \frac{1}{c}}{\frac{l_p^2}{\bar{\lambda}_u}} = \frac{1}{l_p} \frac{\hbar}{l_p} \frac{1}{c} = \frac{m_p}{l_p} \quad (4)$$

The same naturally holds true for energy, as the rest-mass energy of the universe is simply this multiplied by  $c^2$ . So multiplying by  $c^2$  on both sides would naturally not change this finding. We are not distinguishing here between energy and mass, so with the universe mass we mean all energy and mass in the universe on a mass equivalent form.

In other words, the Haug universe mass divided by the Haug observable universe radius is identical to the Planck mass divided by the Planck length. This result is more important than one might at first think. There is considerable uncertainty in the Planck length (see 2018 NIST CODATA) measures and therefore in the Planck mass divided by the Planck length numerical value. However, since the Hubble constant is directly linked to the Planck length and the universe mass and the universe radius, then the exact same uncertainty is in the numerical ratio of the observable universe mass divided by the universe radius. This means the more accurately we know the Hubble radius, the more accurately we know the Planck length, and the more accurately we know the Planck length, the more accurately we know the universe radius (the Hubble radius). They are two aspects of the same thing. As we have recently demonstrated, the Planck length can be extracted from a series of gravity phenomena without knowledge of  $G$ , also without knowledge of  $G$  and  $\hbar$ , and even with no knowledge of  $G$ ,  $\hbar$  and  $c$ ; see [3, 25]. We can even extract the Planck length from cosmological red shift [26]. From only two constants, the speed of gravity that we can easily extract from gravity observations only (without the need of LIGO or any very advanced apparatus) and the Planck length, in addition to variables related to the specific situation, we can predict all observable gravity phenomena and also cosmological phenomena.

The observable universe is likely the largest structure we can know something about, or at least observe. Similarly, the Planck length and the Planck time are the shortest possible length and time. In the Friedman [27] model of the universe, the critical mass (mass equivalent of all the energy and mass in the critical universe) is given by:

$$M_c = \frac{c^3}{2H_0 G} \quad (5)$$

In this model we must at the quantum level have:

$$M_c = \frac{\hbar}{\bar{\lambda}_c} \frac{1}{c} \quad (6)$$

where  $\bar{\lambda}_c$  is the reduced Compton wavelength of the Friedmann critical universe mass (energy). We are not distinguishing between energy and mass here, as energy easily can be seen as equivalent mass based on Einstein's  $E = m/c^2$ . The Hubble constant in the Friedmann model from a quantum perspective must be given by [16]:

$$H_0 = \frac{c\bar{\lambda}_c}{2l_p^2} \quad (7)$$

Be aware that the Friedmann model can be derived also from our [15] new unified quantum gravity model if one simply ignore to take into account Lorentz relativistic mass. The advantage of this is that the Friedmann model derived from our unified quantum gravity model is compatible with quantizing even cosmological scale objects. In general, one cannot just insert  $\hbar$  in cosmological scale objects formulations from general relativity theory, as general relativity theory and quantum mechanics are not compatible, but collision space-time unified quantum gravity is fully compatible with this.

The predicted Hubble constant is the same in the Friedmann universe as the Haug universe because the reduced Compton wavelength of the mass in the Friedmann universe is twice that in the Haug universe. This means we must have the following relation:

$$\frac{M_c}{R_H} = \frac{1}{2} \frac{m_p}{l_p} \quad (8)$$

In other words, this is off by a half compared to that of in the Haug universe. The reason for this is that general relativity theory ignores Lorentz's [28] relativistic mass. That the followers of general relativity theory, for example [29–31] have strongly ignored relativistic mass, even without first investigating all the things including relativistic mass, leads to.

In a working paper, Haug [5] speculatively indicates one could have  $\frac{M_u}{R_u} = \frac{m_p}{2\pi l_p}$ . We now know this is not fully correct as there is a  $\pi$  too much in the denominator to be correct for the Friedmann model; secondly, it is a  $2\pi$  too much to be correct for the Haug model.

Baht and Becker [6] suggest  $\frac{M_H}{\theta} = \frac{m_p}{2l_p}$  where  $\theta$ , according to them, is the diameter of the particle horizon, further  $M_H$  is the mass (or energy equivalent mass) inside this horizon. Baht and Becker suggest  $\Theta = 2 \frac{c}{H_0} \left(\frac{3}{2}\right)^3 \approx 8.8 \times 10^{26} \text{ m}$  (when  $H_0 \approx 70.95$ ). This can be seen as the radius of the universe including expanding space since the time of the Big Bang. There is no expanding of space in the Haug model of the universe. If one sets  $\theta = R_H$  and  $M_H$  equal to the Haug mass, then their somewhat speculative suggestion corresponds to the exact result of the Haug model.

Also from the Haug model of the universe, we have:

$$\hbar = M_u H_0 l_p^2 \quad (9)$$

or

$$\hbar = \frac{M_u}{R_H} l_p^2 c \quad (10)$$

and in the Friedmann critical universe model

$$\hbar = \frac{1}{2} M_c H_0 l_p^2 \quad (11)$$

or

$$\hbar = \frac{1}{2} \frac{M_c}{R_H} l_p^2 c \quad (12)$$

Bhatt and Becker [6] suggested

$$\hbar = \frac{2M_H}{\Theta} l_p^2 c \quad (13)$$

The Bhatt and Becker result do not correspond directly to the Friedmann critical universe or the Haug universe, but to the Friedmann model that goes beyond the critical universe, so it should also give the correct  $\hbar$  for their suggested input parameters. In the Haug universe there is no critical universe, only the observable universe, where the Hubble radius likely is an information horizon. Any point in the universe can likely not be reached by information outside the information horizon. The Haug universe model seem however to indicate an infinite lasting universe that is steady state, that is nonexpanding. Still the analysis here is about the observable universe, which in the Haug universe is the Hubble sphere.

Since we can extract the Planck length from a long series of gravity phenomena without knowing  $G$  and  $\hbar$ , as demonstrated by Haug in recent years, then the relations above are more than just some fancy re-writing of some

math, replacing some constants with others. Instead, it shows the quantum parameters of the universe are directly linked to the cosmological scales. We have strong reasons to think the Haug model of the universe is the correct model, because it does not need dark energy [32] to give very accurate supernova predictions; further, it matches all the properties of the Planck scale for a micro black hole with a mass equal to the Planck mass. General relativity theory cannot do that.

### 3 Compton wavelength of the universe

The reduced Compton wavelength of the observable universe in the Haug model is given by:

$$\bar{\lambda}_u = \frac{\hbar}{M_u c} \quad (14)$$

but this can also be found from the radius of the universe since we must have

$$\bar{\lambda}_u = \frac{l_p^2}{R_H} \quad (15)$$

or since  $R_H = \frac{c}{H_0}$  we naturally also have

$$\bar{\lambda}_u = \frac{l_p^2 H_0}{c} \quad (16)$$

In the Friedmann universe we must have

$$\bar{\lambda}_c = \frac{2l_p^2}{R_H} \quad (17)$$

and

$$\bar{\lambda}_c = \frac{2l_p^2 H_0}{c} \quad (18)$$

Again, we see there is a link between the largest and the smallest. The Compton wavelength of the universe mass can be measured independent of any knowledge of  $G$  or  $\hbar$ , see [26].

Further, the universe density in the Haug model is related to the Planck density,  $\rho_p = \frac{m_p}{\frac{4}{3}\pi l_p^3}$ , in the following way:

$$\rho_u = \frac{M_u}{\frac{4}{3}\pi R_H^3} = \frac{m_p}{\frac{4}{3}\pi l_p^3} \frac{\bar{\lambda}_u^2}{l_p^2} = \rho_p \frac{\bar{\lambda}_u^2}{l_p^2} \quad (19)$$

This means we also have the somewhat interesting result:

$$\frac{\bar{\lambda}_u}{l_p} = \sqrt{\frac{\rho_u}{\rho_p}} \quad (20)$$

where  $\rho_u$  is the mass density in the Haug universe and  $\rho_p$  is the Planck mass density. That is, the ratio of the reduced Compton wavelength of the universe divided by the reduced Compton wavelength of the Planck mass is equal to the square root of their densities. Similarly, in the Friedmann model for the critical universe we must have:

$$\rho_c = \frac{M_c}{\frac{4}{3}\pi R_H^3} = \frac{m_p}{\frac{4}{3}\pi l_p^3} \frac{\bar{\lambda}_c^2}{2l_p^2} = \rho_p \frac{\bar{\lambda}_c^2}{2l_p^2} \quad (21)$$

and therefore:

$$\frac{\bar{\lambda}_c}{l_p} = \sqrt{\frac{2\rho_c}{\rho_p}} \quad (22)$$

where  $\rho_c$  is the density of the critical Friedmann universe (inside the Hubble sphere) and  $\rho_p$  is the Planck mass density. It is important to be aware these are not speculative approximations but exact results from an extensive framework for quantum gravity and quantum cosmology.

Kilogram density of universe in Haug model is given by

$$\frac{M_u}{\frac{4}{3}\pi R_H^3} = \frac{3H_0^2}{G4\pi} = \frac{3\hbar\bar{\lambda}_u^2}{4\pi l_p^6 c} \quad (23)$$

	Haug universe:	Friedmann critical universe:
Hubble constant	$H_0 = \frac{\lambda_u c}{l_p^2}$	$H_0 = \frac{\lambda_c c}{2l_p^2}$
Hubble Radius	$\frac{c}{H_0} = \frac{l_p^2}{\lambda_u}$	$H_0 = \frac{2l_p^2}{\lambda_c}$
Mass	$M_u = \frac{c^3}{GH_0} = \frac{\hbar}{\lambda_u} \frac{1}{c}$	$M_c = \frac{c^3}{2GH_0} = \frac{\hbar}{\lambda_c} \frac{1}{c}$
Mass radius ratio	$\frac{M_u}{R_H} = \frac{m_p}{l_p}$	$\frac{M_c}{R_H} = \frac{1}{2} \frac{m_p}{l_p}$
Compton Planck length ratio	$\frac{\lambda_u}{l_p} = \sqrt{\frac{\rho_u}{\rho_p}}$	$\frac{\lambda_c}{l_p} = \sqrt{\frac{2\rho_c}{\rho_p}}$
Compton Planck length ratio	$\frac{\lambda_u}{l_p} = \sqrt{\frac{\lambda_u}{R_h}}$	$\frac{\lambda_c}{l_p} = \sqrt{\frac{2\lambda_c}{R_s}}$
Planck constant from cosmos	$\hbar = M_u H_0 l_p^2$	$\hbar = \frac{1}{2} M_c H_0 l_p^2$
Planck constant from cosmos	$\hbar = M_u \lambda_u c$	$\hbar = M_c \lambda_c c$
Density of the universe	$\rho = \frac{3\hbar\lambda_u^2}{4\pi l_p^6 c}$	$\rho = \frac{3\hbar\lambda_c^2}{8\pi l_p^6 c}$
Mass of the photon shell	$M_u = \frac{4\pi R_H^2}{4\pi l_p^2} m_\gamma \frac{c}{R_h} = \frac{c^3}{GH_0}$	$M_c = \frac{4\pi R_H^2}{4\pi l_p^2} m_\gamma \frac{c}{R_s} = \frac{c^3}{2GH_0}$
Curvature of Hubble sphere	$\frac{1}{R_H} = \frac{\lambda_u}{l_p^2}$	$\frac{1}{R_H} = \frac{\lambda_c}{2l_p^2}$

**Table 1:** The table shows a series of cosmological properties (aspects) expressed in quantum cosmology.

Kilogram density of universe is in the Friedmann critical universe model

$$\frac{M_c}{\frac{4}{3}\pi R_H^3} = \frac{3H_0^2}{G8\pi} = \frac{3\hbar\lambda_u^2}{8\pi l_p^6 c} \quad (24)$$

## 4 Cosmological constant

Einstein's cosmological constant is typically given by;  $\Lambda = 3 \left( \frac{H_0}{c} \right) \Omega_\Lambda$ . we can re-write it on quantum form as

$$\Lambda = 3 \left( \frac{H_0}{c} \right) \Omega_\Lambda = 3 \frac{1}{M_U^2 c^2} \Omega_\Lambda = 3 \frac{\frac{\hbar^2}{l_p^4}}{\frac{\hbar^2}{M_U^2} c^2} \Omega_\Lambda = 3 \frac{m_p^2}{M_u^2} \frac{1}{l_p^2} \Omega_\Lambda = 3 \frac{\bar{\lambda}_u^2}{l_p^4} \approx 3 \times 5.74 \times 10^{-53} \times \Omega_\Lambda \text{ m}^{-2} \quad (25)$$

This is basically the same result already given by Bhatt and Becker [6] except they drop the 3 in front and indirectly puts the  $\Omega_\Lambda = 1$ , their formula is  $\Lambda = \frac{m_p^2}{M_H^2} = \frac{(2l_p)^2}{\Theta^2}$ , where  $\Theta$  is the diameter of the universe and the output units now are in  $l_p^{-2}$  rather than in meters as in the formulation above, both are used. The Bhatt and Becker result is true if  $M_H$  is the mass of the Haug universe, but not if it is the mass of the Friedmann critical universe as one then would need some modification. Here based on our new quantum gravity theory we know this is an exact relation (based on this model).

## 5 The mass of a Hubble surface photon shell is identical to the mass of the observable universe

In the Haug [18] model of the universe the escape velocity and the orbital velocity are identical and equal to the speed of light at the Hubble radius. That is  $v_e = v_o = c$  when  $R=R_H$ . Assume now we filled the Hubble surface,  $4\pi R_H^2$  with building blocks of photons. Assume the building blocks of photons have Planck surface area of  $4\pi l_p^2$ . This will give a total number of photons that there is space for at the Hubble surface to be

$$\frac{4\pi R_H^2}{4\pi l_p^2} \approx 6656 \times 10^{121} \text{ photon (building blocks)} \quad (26)$$

These photons are mass-less if the photons are not colliding with each other. Even in standard physics a photon-photon collision is assumed to be able to create mass, see [36, 37].

Next assume these photons move out from the Hubble surface and toward the centre of the Hubble sphere. There at the centre of the Hubble sphere they would all collide with another photon of the same type. Assume these particles each with Planck surface area has the hypothetical rest mass of a photon. Well, a photon has no

rest mass, but with rest-mass of the photon we here point to the mass that is created at a photon-photon collision. After all how can also a photon move during the collision with another photon, it can likely not see [25]. Spavieri. et. al [38] have based on classical and quantum approaches estimated the hypothetical photon mass to of the order of about  $10^{-51}$  kg. In the Haug model the photon mass is exactly equal to the Planck mass times the Planck time at the duration of a photon-photon collision. When not colliding but moving at the speed of light the photon in this model is also massless. The very collision between photons is in this model the very origin of mass, that is the only pure mass that is the building blocks of all masses. This gives a mass of  $m_p t_p \approx 1.17 \times 10^{-51}$  kg second, if we use speed of light in meters per second. This mass will increase or decrease as one change time units, but here with change of time units one change also the observational window of the time one observes the photon-photon collision. The photon-photon collision only last the Planck time and is not physically affected by how long we observe it, so it is not like the duration of this collision changes. To change the observation window of something only lasting the Planck time is however mathematically kind of dividing the effect off this event out by the time interval one observes it in. Assume these photons hypothetically travel with the speed of the light from the surface of the Hubble sphere to the centre of the Hubble sphere. There they will collide with a similar photons coming from the opposite side, there will be a massive amount of photon-photon collision (but all the collisions could be divided over a very long time period). The aggregated mass of all the photons in the photon shells then need to be

$$\frac{4\pi R_H^2}{4\pi l_p^2} m_\gamma \frac{c}{R_H} = \frac{4\pi R_H^2}{4\pi l_p^2} m_p t_p \frac{c}{R_H} = \frac{R_H}{l_p^2} \frac{\hbar}{c} = \frac{l_p^2}{\lambda_u} \frac{\hbar}{c} = \frac{\hbar}{\lambda_u} \frac{1}{c} = M_u \approx 1.77 \times 10^{53} \text{ kilogram} \quad (27)$$

This is identical to  $M_u = \frac{c^3}{G H_0} \approx .77 \times 10^{53}$  kilogram. This is twice that of the mass (equivalent) in the Friedmann critical universe, and exactly the same as that predicted in the observable Haug universe. We are naturally not saying this is what is happening. But, perhaps the Hubble constant and the mass (mass equivalent as it naturally also could be energy) of the universe is linked to that the Hubble sphere is somehow a sphere with a photon shell. This should be investigated further.

However this is not as unique as it looks, any object with a escape speed of  $c$  at a the escape speed radius ( $R_h = \frac{GM}{c^2} = \frac{l_p^2}{\lambda}$ ) when taking into account Lorentz relativistic mass, then if one fill the surface of such a sphere with such photon building blocks as described above and then let them collide at the frequency of  $\frac{c}{R_h}$  then the mass of the photons in the shell of such a sphere will have exactly the same mass as the object inside this sphere. This could be interpreted that the equivalent to a black hole is not really a black hole with all the mass in the center (as a singularity as assumed by general relativity theory), but rather an object with a photon shell at a radius equal to half the Schwarzschild radius,  $R_h = \frac{1}{2} R_s$ . Assume a mass inside a sphere with a radius  $\frac{GM}{c^2}$ , this is the radius where the escape velocity is  $c$  when taking into account Lorentz relativistic mass. We now have the following relation

$$\frac{4\pi R_h^2}{4\pi l_p^2} m_\gamma \frac{c}{R_h} = \frac{4\pi (GM/c^2)^2}{4\pi l_p^2} m_p t_p \frac{c}{GM/c^2} = \frac{GM/c^2}{l_p^2} \frac{\hbar}{c} = M \quad (28)$$

In the special case  $R_h = l_p$  then the result is that  $M = m_p$  and this means that the smallest object with such a photon "shell" is the Planck mass. This is in our view nothing more than a single photon photon-collision. Some will likely protest here as the Planck mass is about  $10^{-8}$  kg, so it is way larger than any observed photon, based on that we convert the photon energy to mass by  $m = E/c^2$ . However as explained in several papers, the photon mass is the only mass that always is observational time window dependent. It only last the Planck time, so if observed inside that Planck time it has a mass of the Planck mass. But if exactly the same mass is observed over one second then its mass is  $m_p t_p \approx 1,17 \times 10^{-51} \text{ kg} \cdot \text{s}$ .

In general relativity we would get

$$\frac{4\pi R_s^2}{4\pi l_p^2} m_\gamma \frac{c}{R_s} = \frac{4\pi (2GM/c^2)^2}{4\pi l_p^2} m_p t_p \frac{c}{2GM/c^2} = \frac{GM/c^2}{l_p^2} \frac{\hbar}{c} = 2M \quad (29)$$

If one now set  $R_s$  to  $l_p$  one get a mass of  $2m_p$  inside this sphere with radius equal to the Planck length, we think this is incorrect and is due to general relativity theory ignoring Lorentz relativistic mass, which is also why general relativity theory not can match up with the full Planck scale for a micro black hole see Haug [34].

What if most of the hidden [39] energy (mass) in the universe is actually in the photon shell and not dark energy (or that dark energy is the mass of the photon shell) ? The baryonic density is supposedly only about  $1.7 \times 10^{-31} \text{ g cm}^{-3}$  while the critical density in the Friedmann model is  $9.21 \times 10^{-30} \text{ g} \cdot \text{cm}^{-3}$  and the mass density in the Haug universe is approximately  $1.84 \times 10^{-29} \text{ g} \cdot \text{cm}^{-3}$ . Then what is all the rest of the mass(energy), it cannot be excluded much of it is in a photon shell around the Hubble sphere, but other explanations and possibilities should also be investigated before any conclusions are made.



## 6 Collision space-time mass

The kilogram mass was first well accepted in the physics communities in Europe around 1870. The kilogram mass is clearly a human arbitrarily chosen clump of matter. It is not a natural fundamental quantity of matter. The laws and forces of nature do not care if we call a clump of a given quantity of mass a kilogram or a pound. Not only that, but the kilogram mass is also in our view an incomplete mass that does not take into account the collision-time between photons making up the mass. Please read up on collision-space time, for example [14]. For this and other reasons, we have come to the conclusion that a much more complete mass definition, which we have coined collision-time, it is given by:

$$\bar{m} = t_p \frac{l_p}{\lambda} = \frac{l_p}{c} \frac{l_p}{\lambda} \quad (30)$$

This is the same as the kilogram mass multiplied by  $G/c^3$  that again is the same as the kilogram mass multiplying with  $l_p^2/\hbar$ . So standard theory already embedded (but "hidden") have this mass in all of gravity, as one always has  $GM$  in all observable gravitational phenomena.  $GMm$  we only have in the gravity force formula itself, but  $m$  always cancels out in derivations to calculate something that also can be observed, see for example Haug [3]. In terms of collision-time, the Planck mass is simply:

$$\bar{m} = \frac{l_p}{c} \frac{l_p}{l_p} = t_p \quad (31)$$

that is, the Planck mass is simply the Planck time (in terms of collision-time mass). So the Planck mass divided by the Planck length is now:

$$\frac{\bar{m}}{l_p} = \frac{t_p}{l_p} = \frac{\frac{l_p}{c}}{l_p} = \frac{1}{c} \quad (32)$$

Further, the universe mass is now given by:

$$\bar{M}_u = \frac{l_p}{c} \frac{l_p}{\lambda_u} \quad (33)$$

Quantization is normally linked to the Planck constant and there is no Planck constant in our mass. However, the term  $\frac{l_p}{\lambda_u} \approx 8.05 \times 10^{60}$  should, in this theory, be interpreted as the number of collisions between photons making up matter (and energy) in an observational window equal to the Planck time; see [33]. For masses smaller than the Planck mass, this factor will be less than one and then represents the probability for the particle in question to be in a collision state in the Planck time window.

The universe mass divided by the Hubble radius is now:

$$\frac{\bar{M}_u}{R_H} = \frac{\frac{l_p}{c} \frac{l_p}{\lambda_u}}{\frac{l_p^2}{\lambda_u}} = \frac{1}{c}$$

So we have:

$$\frac{\bar{M}_u}{R_H} = \frac{\bar{m}_p}{l_p} = \frac{1}{c} \quad (35)$$

and naturally also

$$\frac{R_H}{\bar{M}_u} = R_H H_0 = \frac{l_p}{\bar{m}_p} = \frac{l_p}{t_p} = c \quad (36)$$

When linking length and time through the speed of light, we have  $c = 1$  and then these two unique ratios are one. In the Friedmann model, when converting the mass to collision-time mass, we would get:

$$\frac{\bar{M}_c}{R_H} = \frac{\bar{m}_p}{2l_p} = \frac{1}{2c} \quad (37)$$

and when linking length and time through the speed of light we have  $c = 1$  and this ratio is  $\frac{1}{2}$ . This is directly related to that the Friedmann model cannot fully match the Planck scale for micro black holes, as pointed out recently; see [34, 35].

The collision-time mass density of the universe is in Haug model



$$\frac{\bar{M}_u}{\frac{4}{3}\pi R_H^3} = \frac{3H_0^2}{G4\pi} = \frac{3\bar{\lambda}_u^2}{4\pi l_p^4 c} \quad (38)$$

Further the collision-time mass density of the critical universe must in the Friedmann model be

$$\frac{\bar{M}_c}{\frac{4}{3}\pi R_H^3} = \frac{3H_0^2}{G8\pi} = \frac{3\bar{\lambda}_u^2}{8\pi l_p^4 c} \quad (39)$$

## 7 Conclusion

We have demonstrated that in the Haug universe the mass of the universe (the mass inside the Hubble sphere) divided by the Hubble radius is exactly equal to the Planck mass divided by the Planck length. Further, the critical mass in the Friedmann model divided by the Hubble radius is exactly half of the Planck mass divided by the Planck length. We think the Friedmann model is incomplete since it is rooted in general relativity theory that does not consider Lorentz's relativistic mass. Further, when we use the more complete mass definition of collision-time, then the Planck mass divided by the Planck length is simply  $\frac{1}{c}$  and also the universe mass (inside the Hubble sphere) divided by the Hubble radius is then also  $\frac{1}{c}$ . If linking length and time through the speed of light, we must set  $c = 1$  and then both these ratios are exactly 1. We must conclude that the conjecture of Hermes Trismegistus was correct: we indeed have *as above, so below!*

Further we have demonstrated that the mass of the observable universe could exist in the Hubble sphere surface in form of it could be filled with the building blocks of photons, and one then take the mass equivalence of these as described in this paper and one get the mass of the observable universe.

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