Compton Particles and Quantum Forces

in a holo-fractal universe

Martin Mayer*

Augsburg, Germany

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Abstract

An alternative physical model for fundamental particles, fundamental forces & black holes is presented based on classical physics, an unconventional variant of quantum physics as well as holographic & fractal principles. The presented model is primarily based on work from Horst Thieme and Nassim Haramein. In this document their concepts are combined, refined and extended into a joint model that is wider in scope. Furthermore elements were taken from the work of Randell Mills and Erik Verlinde. The deduced equations produce a good number of interesting results and new understandings which might be perceived as controversial with regard to contemporary physics. The presented content covers a broad range of topics in physics to demonstrate the model's wide applicability and to spark more future research. Most notably probabilistic quantum physics is not necessary for the presented model and its noteworthy results.

Keywords: Compton wavelength; electron; proton; neutron; muon; tau; photon; hydrogen; quantum; space-time; gravity; special relativity; general relativity; mass; charge; strong force; Planck units; Planck's constant; black hole; Schwarzschild; Kerr; holographic principle; gravitational constant; spin; de Broglie wavelength; Schrödinger equation; uncertainty; electromagnetism; dipole; fractal; dark energy; dark matter; Hubble constant; force unification; entropy; thermodynamics; octahedron; tetrahedron; Platonic solids

1 INTRODUCTION

When the author of this document read Horst Thieme's book "Das entzauberte Elektron"** (1) it triggered a series of ideas and insights. In particular that it might be possible to generalize Thieme's electron model so that it also applies to other fundamental particles and that his electron model could be related to the work of Nassim Haramein (2).

The internal structure of the electron is still a mystery today and the electron is often even proclaimed to be a point particle with no spatial extent which even makes the concept of an internal structure moot. Thieme's view though is different: he models the electron as a spinning sphere composed of elementary dipoles which are polarized by a presumed central charge monopole. In his book Thieme works out the electron's different aspects like radius, rest mass, spin and self energy composition in addition to considering conformity with contemporary physics and experimental evidence.

Haramein's paper "Quantum Gravity and the Holographic Mass" (2) is centred on explaining proton mass by applying holographic and geometric considerations. Similar to Thieme's approach Haramein uses a fundamental building block which he calls the "Planck Spherical Unit" (abbreviated as PSU) to model the proton. In general Haramein also promotes an understanding of quantized space-time being the creator & bearer of all things which itself is built from an arrangement of octahedrons and tetrahedrons which he calls the "64 tetrahedron grid". According to this view space is never empty and highly organized. Moreover black holes are assumed to play a key role in space-time since Haramein thinks that they are expressions of the holographic & fractal nature of our universe. Other interesting hypotheses of Haramein are that gravity might be the origin of spin in our universe and that the strong

**E-mail: ma.mayer.physics@outlook.com*

***"The disenchanted electron"*

force might be gravitational in nature.

In addition to the concepts of Thieme and Haramein aspects from the work of Randell Mills and Erik Verlinde were adopted on several occasions. The work of Mills has a very broad scope but the core topics are the electron's electric and magnetic fields, the properties of their source charge and molecular bonds (4). Notably the electron model of Mills does not require the use of quantum physics, apart from Planck's constant, and instead his model relies primarily on the classical electromagnetism equations of Maxwell. Although the electron model of Mills is not in full agreement with the model presented in this document several aspects related to electromagnetism were adopted from his work. On the other hand the elaborations on quantum gravity were strongly inspired by the entropic gravity conjecture of Erik Verlinde who has demonstrated that Newtonian gravity can be retrieved from black hole thermodynamics (6). As shown in the quantum gravity section it turned out that Verlinde's entropic gravity notion fits naturally with Harmein's thinking.

Bringing the aforementioned theories together turned out to be a worthwhile endeavour as the distinct theories proved to be related and compatible to some degree though that was not always outright obvious. Once the connection points were established cross checks allowed narrowing down the possible solutions and missing "puzzle pieces" of one theory were occasionally found in one of the others. In the end the synthesis and extension of the individual theories resulted in an increased scope and understanding as presented throughout this document. For example it is repeatedly demonstrated that the Planck units are fundamental quantities of our universe and not just some arbitrary or merely convenient system of physical units.

The terms fractal universe and holographic principle will be used a lot in this document and a short introduction of the terms is given here.
A fractal universe is assumed to express itself at different scales with the same principles and thereby creating unimaginable complexity from a comparatively small set of principles. Presumably this is the most efficient way to construct a whole universe. An ostensive example for a fractal object is the Russian matroschka - each smaller version is similar to the larger one that contained it but they are not identical. The most well-known fractals are computer generated visualizations of the so called Mandelbrot set which can be zoomed endlessly when using appropriate computer software whereby the self similar nature is exposed in a visually impressive way.

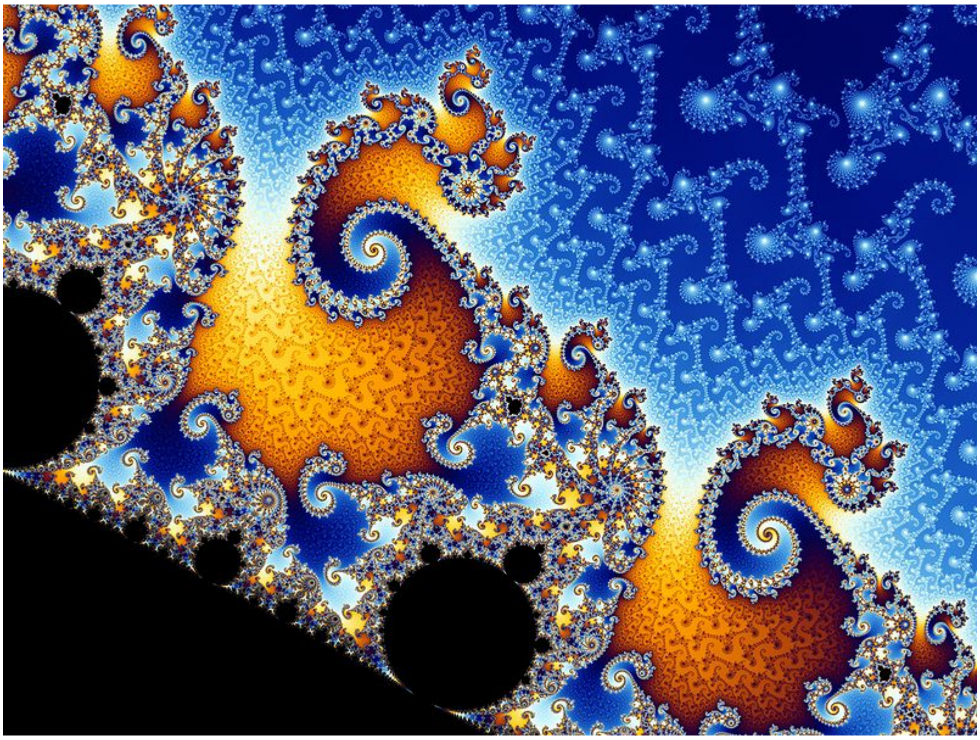

Figure 1: Mandelbrot set visualization*

The holographic principle states that the information contained in a volume of space is also stored on the boundary surface of the given volume whereas the information on the boundary surface is the fundamental one (5). This astonishing principle arose from considerations on black hole thermodynamics and asking what would happen to the information associated with a hot gas that enters a black hole. The assumptions were that the gas cannot leave the black hole but the associated information must also not be destroyed and that black holes should also define the maximum possible entropy. These conjectures led Bekenstein to the surprising realization that the entropy of a black hole is proportional to its horizon surface and later Hawking finished that work by calculating the exact entropy and deriving the associated black hole temperature. This realization was subsequently generalized into the holographic principle since any region of space could turn into a black hole if enough mass enters into it. Consequently the holographic principle should also apply to our universe as a whole and then it should be possible to encode the three dimensional reality that we experience onto a two dimensional surface that encompasses our universe (in case it is bounded). Surface encoding of three dimensional information is actually a key property of two dimensional holographic images which is the reason why the holographic principle got its name.

2 COMPTON PARTICLES

Thieme suggested that electrons are spherical objects which spin so fast that their equatorial ring is moving with light speed (1). Moreover he proposed that internally electrons consist of elementary electric dipoles which are attracted and polarized by a central charge monopole whereas the constituents of each dipole are also spherical. The following figure shows a schematic cut-out of the suggested internal electron structure:

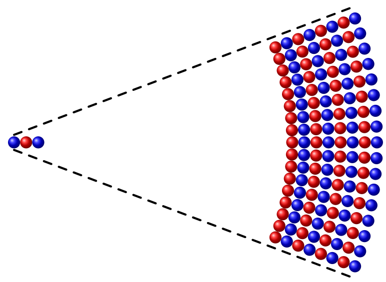

Figure 2: Internal particle polarization

Thieme explained that this structure is similar to what quantum electrodynamics (QED) proposes but according to Thieme's view the minuscule charge carriers are real and not virtual as in QED calculations. Coincidentally Haramein uses a similar spherical model for protons whereas a proton's internal structure consists of tiny Planck length sized spheres which Haramein calls Planck Spherical Units, or PSUs for short (2). This similarity was the first hint that the model of Thieme and Haramein might be interconnected. Both models furthermore assume that the theorized constituents of the respective particle are the fundamental building blocks of space-time. Thus in both models particles can be regarded as self sustaining & spinning distortions in quantized space-time.

Thieme's decision of postulating a maximum surface velocity of light speed c is a sensible choice since it defines a natural particle boundary in space-time and thereby the radius of a spinning spherical particle is also defined naturally & uniquely for a given particle specific rotation frequency. This delineation mechanism can also be regarded as a stall in the quantized space-time medium caused by the circumstance that the space-time surrounding a spinning particle cannot move faster than light speed c and subsequently the polarization effect must become disconnected at a Compton particle's radius. This thinking is in line with Haramein who expressed similar ideas (2) and Randell Mills whose electron model involves surface currents that move with light speed (4).

Thieme used the aforementioned presumptions together with the Compton wavelength to construct a new model of the electron that is strongly anchored in classical mechanics (1). The Compton wavelength λ_c is a renowned quantity of fundamental particles that got determined in numerous photon scattering experiments. It is calculated using the frequency $f_p = c/\lambda_c$ which a hypothetical photon would need to possess an energy hf_p that is identical to the rest mass energy mc^2 of a fundamental particle with mass m whereas h denotes Planck's constant. Using these relationships, $c = 299\,792\,458\,\mathrm{m/s}$ and $h = 6.626\,070 \times 10^{-34}\,\mathrm{J\,s}$ the Compton wavelength is defined as follows:

$$\lambda_c = \frac{h}{mc} \tag{2.1}$$

Conventional physics claims that the Compton wavelength is a purely quantum physical property with no real expression in classical physics. Thieme rejected this notion and concluded that the reduced Compton wavelength $\lambda_c/(2\pi)$ defines the radius of an unbound electron based on particle spin considerations which will be presented in section 2.3. The plausibility of this radius will be discussed repeatedly throughout this document but first the next section will introduce Thieme's model in more detail and also start generalizing it.

2.1 BASIC MODEL

The idea of using the reduced Compton wavelength as particle radius definition can also be applied to proton, neutron, muon, positron & tau besides the electron and all of these fundamental particles will be referred to as Compton particles from now on. Their radius will be denoted as the Compton radius which is given by:

$$r_c = \frac{\lambda_c}{2\pi} \tag{2.2}$$

Since the circumference of a great circle on a sphere with radius r_c equals $2\pi r_c$ the circumference of a Compton particle is equal to its Compton wavelength which implies that the Compton wavelength is a real physical property in Thieme's model instead of an elusive quantum physical trait.

Assuming a velocity of light speed c at a Compton particle's equatorial ring and using the circular motion relationship $v = r\omega = 2\pi r f$ gives the following frequency

$$f_c = \frac{c}{2\pi r_c} = \frac{c}{\lambda_c} \tag{2.3}$$

and angular frequency:

$$\omega_c = \frac{c}{r_c} = \frac{2\pi c}{\lambda_c} = 2\pi f_c \tag{2.4}$$

From now on ω_c will be referred to as angular Compton frequency and f_c as Compton frequency. Please note that the Compton particle model intrinsically has the following relationship between wavelength, frequency and velocity

$$c = \lambda_c f_c \tag{2.5}$$

which interestingly is also characteristic for electromagnetic radiation in vacuum.

Substituting λ_c in equation 2.1 by using equation 2.5 gives the energy relationship

$$hf_c = mc^2 \tag{2.6}$$

which is structurally identical to the equality $hf_p = mc^2$ which was used for calculating the Compton wavelength λ_c before. But there is an important difference: the Compton wavelength is a real physical property in the Compton particle model and thus the frequency f_c is also a real physical trait of the respective Compton particle whereas f_p refers to the frequency of a fictive photon. Consequently equation 2.6 can be used for the calculation of Compton particle properties in the following sections as the physical link between Compton frequency and particle mass has been established here.

2.2 PARTICLE PROPERTIES

Using the experimental values for the Compton wavelength as stated in NIST's CODATA 2014 and using the equations from section 2.1 some basic Compton particle properties can be calculated.

	Proton	**Neutron**
Wavelength λ_c	$1.321\,410 \times 10^{-15}$ m	$1.319\,591 \times 10^{-15}$ m
Radius r_c	$2.103\,089 \times 10^{-16}$ m	$2.100\,194 \times 10^{-16}$ m
Frequency f_c	$2.268\,732 \times 10^{22}$ Hz	$2.271\,859 \times 10^{23}$ Hz
Energy (hf_c)	$1.503\,277 \times 10^{-10}$ J	$1.505\,350 \times 10^{-10}$ J
Mass (hf_c/c^2)	$1.672\,622 \times 10^{-27}$ kg	$1.674\,927 \times 10^{-27}$ kg

	Electron & Positron	Muon	Tau
Wavelength λ_c	$2.426\,310 \times 10^{-12}$ m	$1.173\,444 \times 10^{-14}$ m	$6.977\,87 \times 10^{-16}$ m
Radius r_c	$3.861\,592 \times 10^{-13}$ m	$1.867\,594 \times 10^{-15}$ m	$1.110\,56 \times 10^{-16}$ m
Frequency f_c	$1.235\,590 \times 10^{20}$ Hz	$2.554\,808 \times 10^{22}$ Hz	$4.296\,33 \times 10^{23}$ Hz
Energy (hf_c)	$8.187\,106 \times 10^{-14}$ J	$1.692\,834 \times 10^{-11}$ J	$2.846\,78 \times 10^{-10}$ J
Mass (hf_c/c^2)	$9.109\,384 \times 10^{-31}$ kg	$1.883\,532 \times 10^{-28}$ kg	$3.167\,47 \times 10^{-27}$ kg

Table 1: Compton particle properties

As expected the calculated masses match with the respective experimental value but please note that this calculation is only valid when assuming that Compton wavelength & frequency are physically real properties. As can be seen from table 1 larger Compton particles have less mass, i.e. the electron is larger in size than the proton but still it possesses less mass. This seems counterintuitive at first but makes sense in the Compton particle model: equations 2.3 and 2.4 show that Compton frequency decreases with increasing radius and consequently energy and mass are decreasing because they are proportional to the Compton frequency according to equation 2.6. This relation also leads to a bold speculation: mass as a separate physical property does not exist as it is dependent on a particle's rotation, e.g. a Compton frequency of zero also implies zero mass.
Reflecting on the nature of energy also supports this line of thinking: energy is always associated with translational or rotational motion or at least the potential for motion. This insight is as fundamental as the known conservation laws and it should also hold true for the domain of fundamental particles. Viewed from this perspective it is sensible that the mass energy of a Compton particle is connected to rotational motion.

The calculated radii though are certainly a cause of debate. High energy scattering experiments led to the assumption that the electron has minuscule size or no spatial extend at all. But table 1 states an electron radius that is even bigger than the proton radius. Furthermore the calculated proton radius is only 25.0% of the value reported by the latest muon based scattering experiments (8.42×10^{-16} m). These results seemingly invalidate the presented model but this conclusion is premature because there are several possible explanations that may resolve these radius oddities:

(a) From black hole physics the phenomenon of frame dragging is known: spinning black holes can drag objects in their vicinity along. According to the presented model Compton particles are spinning extremely fast so that frame dragging effects should occur in the vicinity of their surface. This possibility will be examined in section 3.13.

(b) The size of a Compton particle may depend on its translational speed. A similar phenomenon called length contraction is known from the theory of special relativity and section 2.5 will investigate a potential connection.

(c) Conclusions from scattering experiments involving electrons may have to be reconsidered. When modelled as a Compton particle the electron is not a small object relative to atomic scales and presumably also not impenetrable which leads to a number of concerns:

  - Collisions of fundamental particles with electrons may be inelastic which in turn would make experimental results difficult to interpret and if the inelastic effect is not modelled at all the results will likely be incorrect. The analogy is throwing a spinning mud ball at another spinning mud ball.
  - In his book Thieme cited experimental evidence that photon to electron scattering experiments report different electron sizes depending on the energy of the photons (1) which may suggest that an electron with spatial extent is penetrable. Shooting high energy photons towards an electron may then be the analogue of shooting at a pumpkin with a gun where little can be concluded about the pumpkin size by examining the trajectory of the emerging bullet.
  - In Compton scattering experiments the measured photon may not be the photon that initially collided with the electron as pointed out by Thieme (1). The mechanical analogy is Newton's cradle which features the effect of momentum conservation on colliding pendulum balls.

And most importantly it will be demonstrated repeatedly throughout this document that using the Compton radius for calculations leads to physically sensible results.

Comparing the hydrogen radius which is given by the Bohr radius

$$a_0 = \lambda_{ce}/(2\pi\alpha) = 5.291\,772 \times 10^{-11}\ \text{m} \tag{2.7}$$

with the electron's Compton radius $r_{ce} = \lambda_{ce}/(2\pi)$ reveals that these two radii differ by a factor of $\alpha \cong 1/137$ whereby α denotes the so called fine structure constant or Sommerfeld constant. Thus the relationship of these two radii can be expressed as:

$$\alpha a_0 = r_{ce} \tag{2.8}$$

Please note that the electron's Compton radius refers to a free electron which is not bound to an atom. Thus the radius of the unbound electron is larger by a factor of approximately 137 compared to the radius of hydrogen. This difference is not unreasonably large as explained in section 2.10 which will examine these relationships in more detail and also discuss the occurrence of α in equation 2.7. The electron radius r_{ce} also has an α relationship with the so called classical electron radius $r_{cle} = 2.817\,940 \times 10^{-15}$ m.

$$r_{ce}\,\alpha = r_{cle} \tag{2.9}$$

But the classical electron radius is only of hypothetical interest since no real physical relevance has ever been found for it. As Thieme pointed out the classical electron radius was derived by assuming too much electrostatic self energy and that the correct electrostatic field energy would have been $\alpha m_e c^2$ whereby m_e denotes the electron's mass (1). The topic of Compton particle self energy will be examined in more detail in section 2.7.

2.3 SPIN & ANGULAR MOMENTUM

According to contemporary physics particle spin is a purely quantum physical property with no real expression in classical physics. It is noteworthy in this context that the Schrödinger equation doesn't predict spin and that its successor the Dirac equation is required to get a quantum physical description for spin $\frac{1}{2}$ particles such as the electron. After publication of the Dirac equation the search for an explanation in terms of classical mechanics and angular momentum has mostly ceased since no classical approach could compute the correct spin. Thieme though reviewed the topic again and was able to calculate the correct electron spin using the electron's Compton radius r_{ce} (see equation 2.2).

Before moving on two more equations are deduced which will be useful for calculating particle spin. Using the general frequency relationship $\omega = 2\pi f$ and $hf_c = mc^2$ (equation 2.6) the angular Compton frequency can be expressed in terms of mass:

$$\omega_c = \frac{mc^2}{\hbar} \tag{2.10}$$

Using equation 2.3 and 2.6 it is also possible to express the Compton radius in terms of mass:

$$r_c = \frac{\hbar}{mc} \tag{2.11}$$

It is noteworthy that the last equation features the inverse relationship between Compton radius and particle mass which was already discussed in section 2.2.

First the classical angular momentum calculation will be reproduced which lead to the rejection of a classical explanation for particle spin. The moment of inertia for a spinning rigid sphere is given by:

$$J_s = \frac{2}{5} m r^2 \tag{2.12}$$

Using the angular momentum equation $L = J\omega$, equation 2.10, 2.11 and 2.12 the associated angular momentum can be calculated:

$$\begin{aligned} L = J_s\,\omega_c &= \frac{2}{5}\,m\,r_c^2\,\frac{m\,c^2}{\hbar} \\ &= \frac{2}{5}\,m^2\,r_c^2\,c^2\,\hbar^{-1} \\ &= \frac{2}{5}\,m^2\,\frac{\hbar^2}{m^2\,c^2}c^2\,\hbar^{-1} \\ &= \frac{2}{5}\,\hbar = 0.4\,\hbar \end{aligned} \tag{2.13}$$

A Compton particle should have a spin of $\frac{1}{2}\hbar$ and thus the result of the last equation is not correct but on the other hand it is already fairly close to the expected result which suggests that the used approach is not totally wrong.

One initial model assumption was an equatorial ring velocity of light speed c to get a natural particle boundary in quantized space-time. But when a Compton particle is modelled as rigid sphere its surface velocity will decrease towards the poles which might be an undesirable trait. Looking at the work of Randell Mills on electrons which are bound to hydrogen offers a possible remedy for this issue. In his model a bound electron is also spherical but it possesses a superposition of surface currents that move with light speed along great circles (4). The following schematic will make this idea more obvious by depicting two exemplary surface currents.

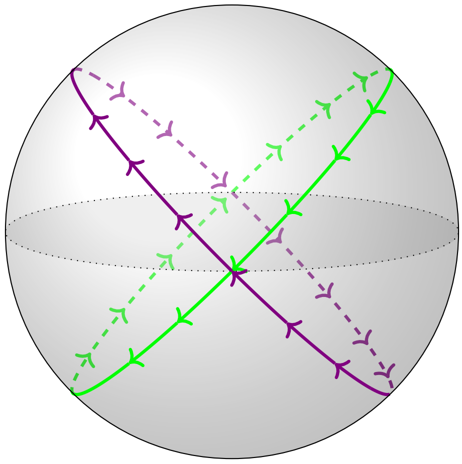

Figure 3: Surface dynamics

Thieme proposed that electrons are composed of small spherical charge carriers which also possess mass. Assuming that these individual charge carriers move along great circles as depicted in figure 3 implies that due to symmetry the sum of their vertical velocity components cancels out which effectively projects the overall angular momentum into the equatorial plane. Furthermore the flow pattern on the surface should be indicative of the flow pattern inside the volume. All these presumptions then lead to the conclusion that the correct moment of inertia for a Compton particle is not that of a spinning rigid sphere but that of an infinitely thin disc. Admittedly the argument is not flawless and the exact flow pattern is not clearly defined yet but the proposed concept is a reasonable hypothesis which may be worked out in more detail by future research. Moreover the flow pattern topic will be revisited in section 2.10 which examines Compton particles in the context of hydrogen.
Please note that the electron model of Mills actually postulates an infinitely thin electron surface but an infinitely thin surface seems to be a non physical trait and therefore this notion is not adapted into the Compton particle model.

Following the reasoning from above a Compton particle's moment of inertia is given by the moment of inertia for an infinitely thin disc which is denoted here as J_d.

$$J_d = \frac{1}{2} m r^2 \tag{2.14}$$

Thieme used this moment of inertia for his electron spin calculations but without giving an explicit justification for why this is the correct moment of inertia term (1). Mills also stated this moment of inertia equation for an electron in the hydrogen ground state (4).
Using equation 2.3, 2.5 and 2.6 it is also possible to express J_d in terms of Compton frequency, angular Compton frequency or Compton wavelength:

$$J_d = \frac{1}{2} m r_c^2 = \frac{1}{2} \frac{h f_c}{c^2} \left(\frac{c}{2\pi f_c} \right)^2 = \frac{1}{4\pi} \frac{\hbar}{f_c} = \frac{1}{2} \frac{\hbar}{\omega_c} = \frac{\lambda_c}{4\pi} \frac{\hbar}{c} \tag{2.15}$$

The last equation allows an easier calculation of angular momentum compared to the approach that was used in equation 2.13 and using J_d a Compton particle's angular momentum, which is denoted by L_c, evaluates to

$$L_c = J_d \, \omega_c = \frac{1}{2} \frac{\hbar}{\omega_c} \omega_c = \frac{1}{2} \hbar \tag{2.16}$$

which is the expected result for spin $\frac{1}{2}$ particles. Please note that this result applies to every Compton particle irrespective of its radius due to the relationships between the involved Compton particle quantities.

As already mentioned contemporary physics claims that it is not possible to calculate particle spin using classical angular momentum equations but as demonstrated in this section that statement is only valid when assuming rigid particles and thereby neglecting the possibility of surface and volume flow dynamics.

2.4 MAGNETIC MOMENT

For a planar current loop the magnetic moment's magnitude M is simply given by AI whereby I denotes the electric current and A the area of the loop. As explained by Thieme this simple formula is sufficient to calculate the electron's magnetic moment since the relevant current is on the particle's surface. Contributions of individual dipoles inside the particle's volume cancel out because each electric dipole consists of a positive and negative charge. In the electron model of Mills also only surface currents are relevant because in his model electric current resides on an infinitely thin sheet. Despite their conceptual differences Thieme and Mills both calculated that the magnetic moment of the unbound electron equals one Bohr Magneton $M_B = e\hbar/(2m_e) = -9.274\,010 \times 10^{-24}$ N m / T (1)(4) whereas m_e denotes the electron's mass and $e = 1.602\,177 \times 10^{-19}$ C denotes the electron's charge.

A possible calculation approach is to "slice" the electron surface into small circuit bands and integrating the magnetic moment of all the individual bands. The circumference of a circuit band is given by $2\pi r \cos\theta$ when the angle θ is chosen to be $0\,\mathrm{deg}$ when perpendicular to the spin axis and $90\,\mathrm{deg}$ when lying in the equatorial plane. The area enclosed by the band is then given by $\pi r_c^2 (\cos\theta)^2$. The electric charge of a single circuit band is given by charge per area $e/(4\pi r^2)$ times the circuit circumference times a small line increment $ds = r\,d\theta$. The current of a circuit band is simply given by the Compton frequency times the charge of a single band. Using these presuppositions and the electron's Compton frequency f_{ce} the integral for the electron's magnetic moment is given by:

$$\begin{aligned}
M &= \int_{-\pi/2}^{\pi/2} A \times I \\
M &= \int_{-\pi/2}^{\pi/2} A \times f_{ce} \times \text{ChargePerArea} \times \text{Circumference} \times \mathrm{d}s \\
M &= \int_{-\pi/2}^{\pi/2} \pi r_{ce}^2 (\cos\theta)^2 \times f_{ce} \times \frac{e}{4\pi r_{ce}^2} \times 2\pi r_{ce} \cos\theta \times r_{ce}\, \mathrm{d}\theta \\
M &= \frac{\pi}{2} f_{ce}\, e\, r_{ce}^2 \int_{-\pi/2}^{\pi/2} (\cos\theta)^3\, \mathrm{d}\theta \\
M &= \frac{2\pi}{3} f_{ce}\, e\, r_{ce}^2 \\
M &= \frac{1}{3} \omega_{ce}\, e\, r_{ce}^2
\end{aligned} \tag{2.17}$$

Using equation 2.10 and 2.11 the magnetic moment evaluates to:

$$M = \frac{1}{3}\frac{m_e c^2}{\hbar} e \left(\frac{\hbar}{m_e c}\right)^2 = \frac{2}{3}\frac{e\hbar}{2m_e} = \frac{2}{3} M_B \tag{2.18}$$

This is not the expected result of one Bohr Magneton but the result is also not totally amiss. Thieme actually used several methods to calculate the electron's magnetic moment and also carried out an integration similar to equation 2.17 but it seems that his integral contains an error which resulted in the expected magnetic moment of one Bohr Magneton.

The wrong result of equation 2.18 indicates that it is also necessary to consider the surface dynamics as depicted in figure 3 for calculating the magnetic moment. Due to the symmetry of the surface dynamics the situation actually seems to simplify to a two dimensional case with one circuit loop that possesses an electric current ef_{ce} and area πr_{ce}^2. Then the unbound electron's magnetic moment M_e evaluates to

$$M_e = e f_{ce} \pi r_{ce}^2 = e \frac{m_e c^2}{h} \pi \left(\frac{\hbar}{m_e c}\right)^2 = \frac{e\hbar}{2m_e} = \frac{ec^2}{2\omega_{ce}} = M_B = \frac{e}{m_e} L_c \tag{2.19}$$

which is the expected result that matches the experimental CODATA 2014 value with a deviation of less than 1.2 permil (note: the remaining error is due to the yet unaccounted anomalous magnetic moment). Thieme also presented equation 2.19 but without referring to a symmetry argument. Please note that the ability to correctly calculate the electron's magnetic moment is further evidence that Compton radius and Compton frequency are sensible physical quantities. Moreover contemporary physics claims that it is not possible to calculate the electron's magnetic moment using classical physics but equation 2.19 indicates otherwise.

So far the magnetic moment calculations only considered the electron but equation 2.19 can also be generalized to a magnetic moment for Compton particles which will be denoted by M_c.

$$M_c = e\omega_c r_c^2/2 = \frac{e\hbar}{2m} = \frac{e}{m} L_c \tag{2.20}$$

The following table states the absolute values of the magnetic moments for all Compton particles

	Magnetic moment M_c	CODATA 2014 value	Deviation
Electron & Positron	9.27401×10^{-24} N m/T	9.28476×10^{-24} N m/T	1.001159
Proton	5.05078×10^{-27} N m/T	1.41061×10^{-26} N m/T	2.792854
Neutron (charged)	5.04383×10^{-27} N m/T	9.66237×10^{-27} N m/T	1.915681
Muon	4.48522×10^{-26} N m/T	4.49045×10^{-26} N m/T	1.001166
Tau	2.66713×10^{-27} N m/T	Unknown	Unknown

Table 2: Magnetic moments

and two things are apparent from it: for smaller particles the deviation of calculated to measured magnetic moment is larger and the values in the 'deviation' column are half of the so called g-factor. The proton has the biggest deviation from M_c and the suspected cause is that one or more of the assumptions that were made for the calculation of the electron's magnetic moment break down for substantially smaller particles and therefore the simple single current loop approximation (equation 2.19 and 2.20) is no longer appropriate. Because the presented model assumes that every Compton particle is internally polarized the magnetic moment of the neutron was also calculated with assuming a charge e. In his book Mills proposed that the neutron's surface charge is actually composed of half positive and half negative charge (11) which might explain why the neutron can have a magnetic moment and still appear as electrically neutral. The result for the muon on the other hand is surprisingly correct although it is already considerably smaller in size than the electron.

2.5 DE BROGLIE FREQUENCY

Experiments have shown that fundamental particles exhibit wave like behaviour which is determined by the so called de Broglie wavelength λ_b. The non-relativistic formulation of the de Broglie wavelength is given by

$$\lambda_b = \frac{h}{p} = \frac{h}{mv} \quad \text{(for } v \ll c\text{)} \tag{2.21}$$

whereby p denotes a particle's linear momentum mv and v is its velocity. As noted by Thieme the equation for the de Broglie wavelength is structurally similar to the Compton wavelength equation (1):

$$\lambda_c = \frac{h}{mc} \tag{2.1}$$

Thieme reasoned that both wavelengths might be connected physically and in fact as a particle's velocity increases towards c its de Broglie wavelength tends to the Compton wavelength. This correlation can also be expressed as follows:

$$\frac{\lambda_c}{\lambda_b} = \frac{v}{c} \quad \text{(for } v \ll c\text{)} \tag{2.22}$$

Though the last equation only applies to non-relativistic speeds because the relativistic formulation of de Broglie wavelength requires relativistic momentum. As v approaches c the associated relativistic momentum actually approaches infinity and subsequently the associated relativistic de Broglie wavelength tends to zero. The relativistic case will be treated in more detail below (see equation 2.28).

In the Compton particle model Compton wavelength & frequency are related by

$$c = \lambda_c f_c \tag{2.5}$$

and a similar relationship can be formulated for the de Broglie wavelength

$$c = \lambda_b f_b \tag{2.5}$$

whereby f_b denotes a quantity which will be referred to as the de Broglie frequency:

$$f_b = \frac{c}{\lambda_b} = \frac{cp}{h} = \frac{mvc}{h} = \frac{v}{\lambda_c} = f_c \frac{v}{c} \quad \text{(for } v \ll c\text{)} \tag{2.23}$$

Please note that this formulation of the de Broglie frequency differs from the conventional definition. The reason for introducing the de Broglie frequency is that its relativistic variant, which is stated below in equation 2.29, exhibits a physically sensible value when a particle's velocity is $0\,\mathrm{m/s}$. In this scenario the relativistic de Broglie wavelength has a nonsensical infinite wavelength but the relativistic de Broglie frequency equals $0\,\mathrm{Hz}$ which is a legit value. This suggests that a convincing theory of quantum physics should treat the de Broglie frequency as the physically relevant parameter instead of the de Broglie wavelength which should only be regarded as a computational quantity.

Actually there is a way to incorporate the aforementioned similarities into the Compton particle model and to give physical meaning to the de Broglie frequency by ascribing it to a Compton particle's second rotation axis. The following figure illustrates the concept by depicting a sphere's two independent rotation axes with the associated frequencies.

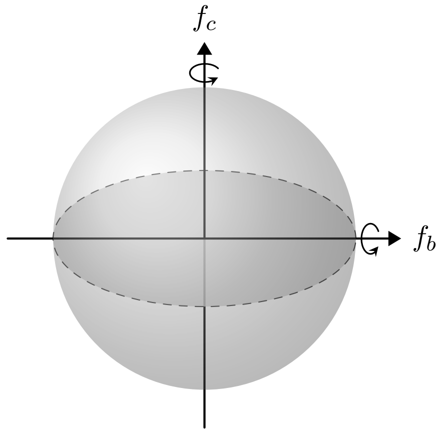

Figure 4: Compton particle frequencies

This notion has a few interesting consequences because it implies that the de Broglie frequency stores energy in a Compton particle in the form of rotational energy. Consequently any change in the particle's velocity causes a change in the particle's rotational energy which presumably is met with resistance that manifests itself as translational inertia. Moreover the energy storage process is expected to account for a particle's relativistic energy because increasing the de Broglie frequency should become increasingly energy consumptive the higher the de Broglie frequency already is.

A particle in vacuum that is subject to a certain force will experience an inertial counter-force F_i that limits the particle's acceleration. It will be shown here, for the non-relativistic case, that this inertial counter-force is depending on the de Broglie frequency. The first step is expressing the linear momentum in terms of the de Broglie frequency and the Compton frequency which can be achieved by rearranging equation 2.21 and using equation 2.1, 2.22 & 2.23:

$$p = \frac{h}{\lambda_b} = mc\frac{\lambda_c}{\lambda_b} = mc\frac{f_b}{f_c} \tag{2.24}$$

Using the last equation and some standard force relationships then gives the following interesting expression for the inertial counter-force

$$F_i = ma_i = \frac{\mathrm{d}p}{\mathrm{d}t} = \frac{\mathrm{d}}{\mathrm{d}t}\frac{h}{\lambda_b} = mc\,\frac{\mathrm{d}}{\mathrm{d}t}\frac{\lambda_c}{\lambda_b} = mc\,\frac{\mathrm{d}}{\mathrm{d}t}\frac{f_b}{f_c} \tag{2.25}$$

that allows extracting an expression for the inertial acceleration a_i which is independent of mass but dependent on change of the de Broglie frequency with time. Using equation 2.22 or 2.23 proves that this expression for a_i is equivalent to change in the particle's velocity with time:

$$a_i = c\,\frac{\mathrm{d}}{\mathrm{d}t}\frac{\lambda_c}{\lambda_b} = \lambda_c\,\frac{\mathrm{d}f_b}{\mathrm{d}t} = c\,\frac{\mathrm{d}}{\mathrm{d}t}\frac{f_b}{f_c} = \frac{\mathrm{d}v}{\mathrm{d}t} \tag{2.26}$$

Although the last equation can be expressed in terms of λ_b or f_b the physically relevant process should be the change in de Broglie frequency f_b and the associated change in a particle's rotational energy.

Up to here only non-relativistic cases haven been treated but examining relativistic particle energy will actually substantiate the presented line of thinking. As defined by special relativity theory a particle's relativistic energy can be expressed in the following way:

$$E_\gamma = \sqrt{(\gamma mvc)^2 + (mc^2)^2} \tag{2.27}$$

Here γmv denotes the relativistic momentum and γ is the Lorentz factor $1/\sqrt{1 - v^2/c^2}$. The relativistic de Broglie wavelength which is denoted here as $\lambda_{b\gamma}$ also involves the Lorentz factor and is given by the expression λ_b/γ. Subsequently the relativistic version of equation 2.22 is given by:

$$\frac{\lambda_c}{\lambda_{b\gamma}} = \gamma \frac{v}{c} \tag{2.28}$$

Using the last equation in equation 2.27 and defining the relativistic de Broglie frequency as

$$f_{b\gamma} = c/\lambda_{b\gamma} = \gamma\, f_b \tag{2.29}$$

then allows expressing the relativistic energy of a Compton particle in terms of wavelengths and frequencies:

$$\begin{aligned} E_\gamma^2 &= \left(mc^2 \frac{\lambda_c}{\lambda_{b\gamma}}\right)^2 + (mc^2)^2 = \left(mc^2 \frac{f_{b\gamma}}{fc}\right)^2 + (mc^2)^2 \\ E_\gamma &= mc^2 \sqrt{1 + \left(\frac{\lambda_c}{\lambda_{b\gamma}}\right)^2} = mc^2 \sqrt{1 + \left(\frac{f_{b\gamma}}{f_c}\right)^2} \end{aligned} \tag{2.30}$$

The $(f_{b\gamma}/f_c)$ term which appears in the last equation can be interpreted as evidence that the Compton frequency and the de Broglie frequency have a physical relationship as asserted before and that rotational energy is really causal for the relativistic energy of a Compton particle.

Comparing equation 2.30 with $E_\gamma = \gamma mc^2$ shows that the Lorentz factor itself can also be expressed in terms of wavelengths and frequencies:

$$\gamma = 1 \Bigg/ \sqrt{1 - \left(\frac{v}{c}\right)^2} = \sqrt{1 + \left(\frac{\lambda_c}{\lambda_{b\gamma}}\right)^2} = \sqrt{1 + \left(\frac{f_{b\gamma}}{f_c}\right)^2} \tag{2.31}$$

Expressing the Lorentz factor γ in terms of $f_{b\gamma}/f_c$ has the interesting trait that γ can be regarded an intrinsic property of the Compton particle. Furthermore these new expressions for the Lorentz factor give interesting expressions for relativistic mass m_γ by inserting equation 2.1 into 2.31:

$$\begin{aligned} m_\gamma = \gamma m &= \frac{h}{\lambda_c\, c} \sqrt{1 + \left(\frac{\lambda_c}{\lambda_{b\gamma}}\right)^2} = \frac{h}{c} \sqrt{\frac{1}{(\lambda_c)^2} + \frac{1}{(\lambda_{b\gamma})^2}} \\ &= \frac{hf_c}{c^2} \sqrt{1 + \left(\frac{f_{b\gamma}}{f_c}\right)^2} = \frac{h}{c^2} \sqrt{(f_c)^2 + (f_{b\gamma})^2} \end{aligned} \tag{2.32}$$

Using these new expressions for relativistic mass in the relativistic energy equation $E_\gamma = m_\gamma c^2$ reveals a new frequency term which will be referred to as the Lorentz frequency f_γ:

$$E_\gamma = m_\gamma c^2 = hc \sqrt{\frac{1}{(\lambda_c)^2} + \frac{1}{(\lambda_{b\gamma})^2}} = h\, \sqrt{(f_c)^2 + (f_{b\gamma})^2} = hf_\gamma \tag{2.33}$$

$$f_\gamma = c \sqrt{\frac{1}{(\lambda_c)^2} + \frac{1}{(\lambda_{b\gamma})^2}} = \sqrt{(f_c)^2 + (f_{b\gamma})^2} = \frac{m_\gamma c^2}{h} \tag{2.34}$$

The Lorentz frequency is presumably related to a shrinking radius of fast moving Compton particles and the corresponding relativistic radius r_γ is subsequently given by:

$$r_\gamma = \frac{c/f_\gamma}{2\pi} = 1 \Bigg/ \sqrt{\left(\frac{2\pi}{\lambda_c}\right)^2 + \left(\frac{2\pi}{\lambda_{b\gamma}}\right)^2} = \frac{c}{\sqrt{(\omega_c)^2 + (\omega_{b\gamma})^2}} = \frac{\hbar}{m_\gamma c} = \frac{r_c}{\gamma} \tag{2.35}$$

Remarkably the last equation resembles the so called Lorentz length contraction of special relativity theory although there is a noteworthy difference: in the presented model a Compton particle will shrink uniformly with increasing velocity whereas special relativity claims that a moving particle only contracts along its direction of motion which would transform a moving Compton particle into a squashed spheroid.

The relativistic equations presented in this section relied on the assumption that the Compton wavelength is independent a particle's velocity which is the commonly accepted view. In case this assumption were invalid the presented relativistic equations would need to be though over.

2.6 SHIELDED CHARGE CORRECTION

Modern quantum physics often uses the concept of short lived virtual particles to explain fundamental fields & the associated forces as well as certain quantum physical phenomena. For example quantum electrodynamics (QED) postulates that virtual electron-positron pairs created in the electron's vicinity constitute short-lived electric dipoles which modify the electron's electric field because they become polarized. Coincidentally it is the Compton radius (equation 2.2) where this polarization effect starts to have significant influence according to QED. In Thieme's electron model however the elementary dipoles that constitute the electron are real as well as stable and a central charge monopole is presumably responsible for the polarization of these dipoles (1). The dipole polarization again effectively shields the presumed central charge monopole so that the electron's charge as observed from outside the particle is smaller than that of the central charge monopole - which is similar to what QED proposes. Thieme calculated the unshielded electron charge in his book (1) and this section will reproduce his calculation.

The electrostatic potential energy U_e for two equal charges q at a distance d is defined by

$$U_e = -\frac{q^2}{4\pi\epsilon_0 d} \tag{2.36}$$

whereby $\epsilon_0 = 8.854\,188 \times 10^{-12}\ \mathrm{F/m}$ denotes the electric field constant. Rearranging for q then gives:

$$|q| = \sqrt{4\pi\epsilon_0\, d\, U_e} \tag{2.37}$$

Identifying the electrostatic potential energy at a given distance for the unshielded charges and inserting these values into the last equation will yield the charge of the unshielded central charge monopole. To find this unshielded charge q_0 the case of an electron positron interaction is examined here. The appropriate distance d is assumed to be the Compton radius of the electron because the electron and positron should have essentially merged at this distance which presumably results in a full depolarization of both particles and the absence of an overall electrostatic field. The next step is to identify the appropriate electrostatic potential energy at that distance. When separating the two particles again the particles' internal structure is restored which requires work that equals their electrostatic potential energy. Moreover Thieme calculated that the electrostatic potential energy of an electron makes up 50% of its self energy $m_e c^2$ (section 2.7 will address the self energy topic in more detail). Hence in the outlined scenario the appropriate electrostatic potential energy is 50% of the electron's self energy plus 50% of the positron's self energy which equals 100% of the electron's self energy. Using this self energy in equation 2.37 and substituting d by the Compton radius (equation 2.11) then gives the magnitude of the unshielded charge q_0:

$$|q_0| = \sqrt{4\pi\epsilon_0\, \frac{\hbar}{m_e c}\, m_e c^2} = \sqrt{2\epsilon_0 hc} = q_l \tag{2.38}$$

Interestingly the unshielded charge $|q_0|$ is equal to the Planck charge q_l which is evidence for the notion that the Planck units are fundamental units of our universe and not just some arbitrary quantities.

Thieme though stated a different value for q_0 in his book (1), namely $\sqrt{\epsilon_0 hc} = q_l/\sqrt{2}$. This result is obtained when, for example, halving the potential energy or distance which was used in equation 2.38. Further calculations done in this document suggest however that the correct unshielded charge is given by Planck charge q_l.

Having calculated the unshielded electron & positron charge allows comparing it with the shielded charge e:

$$\frac{q_l}{e} = \frac{1}{\sqrt{\alpha}} = 11.706238... \tag{2.39}$$

Interestingly this ratio contains the square root of the Sommerfeld constant which is regarded as the coupling constant between charge and the electromagnetic field strength (see also section 3.15). Combining equation 2.38 and 2.39 gives the formal definition of this coupling relationship:

$$\alpha = \frac{e^2}{q_l^2} = \frac{e^2}{2\epsilon_0 ch} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{c\hbar} \tag{2.40}$$

Please note that it is the charged particle polarization concept as presented in this section which explains the Sommerfeld constant's value. If there were no internal particle polarization the Sommerfeld constant's value would be one and the elementary charge e would equal the Planck charge q_l.

The unshielded charge was only calculated for the electron and positron beforehand but it is presumed here that all Compton particles have a Planck charge monopole at their centre which polarizes them - presumably even the seemingly uncharged neutron. Evidence for this notion comes from the following energy equality which represents the generalized version of equation 2.38 and is obtained by combining equations 2.36, 2.38 and 2.3:

$$\frac{q_l^2}{4\pi\epsilon_0 r_c} = \frac{2\epsilon_0 hc}{4\pi\epsilon_0 r_c} = h\frac{c}{2\pi r_c} = hf_c = E_c \tag{2.41}$$

2.7 SELF ENERGY

Thieme provided calculations for the electron's self energy in his book (1) whereby he identified five different energy contributions which are listed in the following table. The used abbreviations are 'kin.' for kinetic, 'magn.' for magnetic, 'pot.' for potential and 'e.s.' for electrostatic.

Source	Ratio of mc^2	Equation	Type
Spinning mass	$1/4 = 0.25$	$0.5\, L_c\, \omega_c$	kin., mass
Rotating charge	$1/4 = 0.25$	$0.5\, \phi_l\, ef_c$	kin., magn.
Centripetal force	$1/8 = 0.125$	$0.5\, L_c^2/(mr_c^2)$	pot., e.s.
Dipole polarization	$1/2.72... = exp(-1)$	$q_l^2/(4\pi\epsilon_0 r_c)\, exp(-1)$	pot., e.s.
External electric field	$1/137... = \alpha$	$e^2/(4\pi\epsilon_0 r_c)$	pot., e.s.
	$1.000177...$		

Table 3: Self energy

The arguments and calculations presented in this section should also apply to other Compton particles, besides the electron, like the positron and muon. This is why the equations in this section will always reference general Compton particle quantities like r_c even if the text is referring to the electron. In case of the proton and neutron it is unclear if they really have self energy contributions which are identical to the ones of the electron because their magnetic moment is not given by equation 2.20 (see also table 2).

The individual contributions are treated in more detail in the following bullet list:

- **Spinning mass**: This energy contribution simply uses the energy equation for spinning mass which is given by $J\omega^2/2$ whereby J denotes the moment of inertia. Using the angular momentum relationship $L = J\omega$ the energy of a spinning mass can also be stated as $L\omega/2$.
- **Rotating charge**: To calculate the magnetic energy contribution due to rotating charge Thieme used the equation for magnetic energy storage in a planar current loop. This approach is similar to the one used for calculating spin and magnetic moment as presented above where a simplified 2D model was used too. Moreover since inductance Υ is related to current I and magnetic flux ϕ by $\Upsilon = \phi/I$ the equation for stored magnetic energy can be expressed as follows:

  $$E_m = \frac{1}{2}\Upsilon I^2 = \frac{1}{2}\frac{\phi}{I}I^2 = \frac{1}{2}\phi I \tag{2.42}$$

  The magnetic energy can then be calculated by assuming a current of $I = ef_c$ and using the magnetic flux quantum $\phi_l = h/2e = 2.067\,834 \times 10^{-15}$ Wb which is the smallest possible magnetic flux as observed in superconductor experiments. Substituting the aforementioned variables in equation 2.42 gives the magnetic self energy contribution as stated in table 3:

  $$\frac{1}{2}\,\phi_l\, ef_c = \frac{1}{2}\frac{h}{2e}ef_c = \frac{hf_c}{4} = \frac{mc^2}{4} \tag{2.43}$$

  Choosing the magnetic flux quantum for this calculation seems to have been an inspired guess by Thieme.
- **Centripetal force**: Thieme reasoned that a centripetal force must hold the dipoles together to counteract the centrifugal force that they experience in a rotating electron. This centripetal force is presumably caused by the central charge monopole and therefore it is electrostatic in nature. For calculating the associated energy contribution Thieme used the centripetal potential equation $L^2/(2mr^2)$. This equation is derived from orbital mechanics and implicitly assumes a moment of inertia of mr^2 which corresponds to a point mass in circular motion or to a rotating loop but this is in conflict with equation 2.14 which states that a Compton particle's moment of inertia is given by $mr^2/2$. However the calculation done by Thieme might

be appropriate when considering that individual dipoles move along great circles as depicted in figure 3 and that Compton particle spin is independent of radius.

- **External electric field**: For calculating this energy contribution Thieme used the electrostatic potential energy equation 2.36 with shielded charge e and distance $d = r_c$. Using an argument similar to the one made in section 2.6 the electrostatic potential energy equation might be appropriate to calculate the energy contained in the electron's external electrostatic field but then this energy should only be 50% of the contribution which is stated in table 3 since the calculated potential energy is associated with the configuration of two particles (which possess equal charge).
  An alternative approach is calculating the energy required for assembling a charged spherical shell with charge e and radius r_c which is given by $3/5 \times 1/(4\pi\epsilon_0) \times e^2/r_c$. The result of this approach corresponds to 60% of the external electric field energy as stated in table 3.
- **Dipole polarization**: Thieme stated that dipole polarization should occur inside an electron which is caused by a presumed central charge monopole. Polarizing the dipoles requires energy and Thieme suggested that the potential energy function $+U_0 \frac{a}{r}\, exp(\frac{-a}{r})$ can be used to calculate the associated polarization energy. This function is reminiscent of the Yukawa potential energy function $-U_0 \frac{a}{r}\, exp(\frac{-r}{a})$ but these functions have quite distinct curves and the following figure depicts a visual comparison of them.

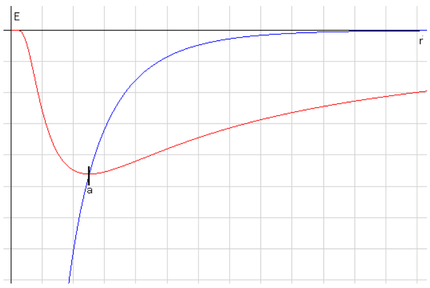

Figure 5: Yukawa potential (blue) & Thieme's potential (red & sign inverted)

To calibrate the potential energy function Thieme assigned the Compton radius to parameter a and for defining U_0 he again used the electrostatic potential energy function. Like in the 'external electric field' case it is not clear if the usage of the electrostatic potential energy is really appropriate and if all of the calculated self energy or half of it should be used for U_0. To get the contribution factor of $exp(-1)$ as cited by Thieme at radius $r = r_c$ it is necessary to use the Planck charge q_l in the calculation and assigning all of the electrostatic potential energy to U_0 so that U_0 equals $q_l^2/(4\pi\epsilon_0 r_c)$. Please note that using the Planck charge makes sense here since it denotes the unshielded electron charge (see section 2.6). Thieme though used a charge of $\sqrt{\epsilon_0 hc} = q_l/\sqrt{2}$ for the dipole polarization energy calculation which doesn't match his stated result because then the contribution factor evaluates to $exp(-1)/2$.

It seems that Thieme identified a sensible set of self energy contributions for the electron but it is not clear if the calculations for the individual contributions are already correct as some concerns have been identified above. Furthermore as can be seen in the last row of table 3 the overall self energy is slightly greater than mc^2 and it is the $\alpha + exp(-1)$ contribution that is responsible for the 0.000177 deviation. On the other hand it is conspicuous that some self energy contributions factors have whole number fractions like 1/4 and 1/8 which suggests that these might be correct. In case that at least the calculated spinning mass energy and rotating charge energy contributions are correct it is sensible to assume that the total electrostatic contribution factor is $1/2$ of the electron's self energy whatever the detailed composition of the electrostatic self energy is.

Further insight on the matter of electron self energy is obtained by comparing the magnetic flux quantum ϕ_l to some other quantities. Using equation 4.16 the relationship between the electron's magnetic moment, which is given by the Bohr Magneton (equation 2.19), and the magnetic flux quantum ϕ_l can be expressed as follows

$$\phi_l = \frac{1}{2}\frac{h}{e} = \frac{1}{2}\frac{\mu_0}{\alpha\, r_c} M_c \tag{2.44}$$

whereas $\mu_0 = 4\pi \times 10^{-7}$ N/A^2 denotes the permeability of vacuum. Interestingly the Sommerfeld constant α is also involved in this relationship for reasons which are not fully understood yet. For comparison the magnetic flux associated with the electron's magnetic moment is calculated next. Therefore the magnetic flux through a disc with area $A = \pi r_c^2$ is determined assuming it possesses a constant magnetic field $B = \mu_0 IN/(2r_c)$ caused by a current $I = ef_c$ that flows in N turns around the disc. Assuming a constant magnetic field is unrealistic if the magnetic field is caused by a current loop but for comparison even an approximate result will be useful. Setting $N = 1$ gives the following flux:

$$A \times B = \pi {r_c}^2 \frac{\mu_0 NI}{2r_c} = \pi {r_c}^2 \frac{\mu_0 e f_c}{2r_c} = \frac{\mu_0 ec}{4} = \frac{1}{2}\frac{\mu_0}{r_c} M_c = \alpha\, \phi_l \tag{2.45}$$

Surprisingly another α relationship appears and comparing equations shows that the magnetic flux as calculated by equation 2.45 is lower than the flux stated in equation 2.44 by a factor of $1/\alpha \cong 137$. This difference can be rectified by setting the number of turns N to $1/\alpha$ but the equations for the magnetic moment (2.19 & 2.20) only used a single turn. The explanation for this disparity in turns may be found in figure 3. The magnetic moment vectors corresponding to the two depicted exemplary current loops cancel out partially but there is no cancellation effect for the energy contributions associated with the magnetic flux of each depicted current loop. This again highlights that Compton particles can only be understood when presuming that they have surface dynamics and a concrete flow pattern is proposed in the electron model of Randell Mills (4).

2.8 PLANCK'S CONSTANT

The previous sections often utilized Planck's constant h and a number of observations and conclusions can be drawn from its uses:

- Energy terms of the form hf do not only apply to photons but also to Compton particles (see section 2.1).
- Planck's constant h is the fundamental rotation to energy conversion constant of our universe. Therefore the physical units of h should better be stated as $\mathrm{J/s^{-1}}$ or J/Hz instead of the commonly used J s. These three expressions are physically equal but the last one conceals the real physical meaning.
- The units of Planck's constant are also identical to the typical units for angular momentum L which are $\mathrm{kg\,m^2/\,s}$.
- Particle mass cannot exist independently of rotation because in case a Compton particle could stop spinning its mass would become zero (see equation 2.6) and consequently mass should be regarded as an emergent quantity. A Compton particle's fundamental quantities are size/length, rotation/motion (which practically is synonymous with energy) and charge/duality.
- The energy of a Compton particle can be expressed in terms of various geometric quantities including the Compton particle circumference $2\pi r_c$ (see also equations 2.3 & 2.6):

  $$E_c = mc^2 = hf_c = h\frac{c}{\lambda_c} = h\frac{c}{2\pi r_c} = \frac{c\hbar}{r_c} \tag{2.46}$$

- All Compton particles share the same ratios of mass, frequency, radius and energy (see also equations 2.3 & 2.6):

  $$h = \frac{mc^2}{f_c} = \frac{E_c}{f_c} = mc\lambda_c \quad \text{or equivalently} \quad \hbar = \frac{mc^2}{\omega_c} = \frac{E_c}{\omega_c} = mcr_c \tag{2.47}$$

- The term $c/\hbar$ can be used to define a new quantity - the Compton acceleration a_c.

  $$\frac{c}{\hbar} = \frac{1}{mr_c} = \frac{c\,\omega_c}{E_c} = \frac{a_c}{E_c} = 2.842\,788 \times 10^{42}\,\frac{\mathrm{m/s^2}}{\mathrm{J}} \cong 2\sqrt{2} \times 10^{42}\,\frac{\mathrm{m/s^2}}{\mathrm{J}} \tag{2.48}$$

  Curiously an approximate $\sqrt{2}$ term is present in equation 2.48 with a deviation from the exact result which is less than 0.51%. This is a relatively large deviation but remarkably more such $\sqrt{2}$ relationships appear in other fundamental equations and constants which are presented in the sections below. Rearranging equation 2.48 for the Compton acceleration a_c yields:

  $$a_c = \frac{c}{\hbar} E_c = c\,\omega_c = \frac{c^2}{r_c} = \frac{c^2}{\lambda_c/2\pi} \tag{2.49}$$

  The circular motion relationship c^2/r_c reveals that the Compton acceleration a_c denotes the centripetal acceleration at the equatorial ring of a Compton particle. Moreover setting r_c to the Planck length l_l gives the so called Planck acceleration $a_l = c^2/\,l_l = 5.560\,816 \times 10^{51}\,\mathrm{m/s^2}$.
- The term $c/\hbar$ constitutes a fundamental scaling factor for acceleration to energy (see equation 2.48) which is why $c/\hbar$ appears in the gravitational acceleration equation when expressed in terms of energy (see equation 3.71).

- The term $\hbar/c$ appears in the fundamental mass equations 2.11, 3.7 & 3.15 because of the mass to energy relationship $m = E_c/c^2 = \hbar/(cr_c)$.
- See section 4.1 for the meaning of the term $c\hbar$ which is linked to the unification of electromagnetic and gravitational force.
- All of the self energy related equations in table 3 can be transformed into hf_c terms as shown by the following equations:

$$L_c\,\omega_c/2 = hf_c/4 \quad \text{(using equations 2.4 \& 2.16)} \tag{2.50}$$

$$L_c^2/(2mr_c^2) = \frac{1}{2}\frac{\hbar^2}{4}\frac{c^2}{hf_c}\frac{2^2\pi^2 f_c^2}{c^2} = hf_c/8 \quad \text{(using equations 2.6, 2.16 \& 2.3)} \tag{2.51}$$

$$q_l^2/(4\pi\epsilon_0 r_c)\,exp(-1) = hf_c\,exp(-1) \quad \text{(using equation 2.41)} \tag{2.52}$$

$$e^2/(4\pi\epsilon_0 r_c) = hf_c\,\alpha \quad \text{(using equations 2.41 \& 2.40)} \tag{2.53}$$

The rotating charge energy contribution was already expressed as hf_c term in equation 2.43. Being able to express all these self energy contributions as hf_c terms demonstrates that all of them are fundamentally linked to a Compton particle's rotation - even the electrostatic energy contributions.

2.9 SCHRÖDINGER EQUATION

This section will examine the Schrödinger equation in the Compton particle context by examining its time independent variant which is given by:

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}[E_{tot} - E_{pot}(x)]\psi = 0 \tag{2.54}$$

Using equation 2.1 and 2.6 the term $2m/\hbar^2$ can be reformulated in terms of Compton wavelength, Compton frequency and Compton radius:

$$\frac{2m}{\hbar^2} = \frac{8\pi^2 m}{\lambda_c^2 m^2 c^2} = 2\left(\frac{2\pi}{\lambda_c}\right)^2 \frac{1}{hf_c} = 2\frac{1}{r_c^2}\frac{1}{hf_c} \tag{2.55}$$

Inserting equation 2.55 into 2.54 leads to the following variants of the Schrödinger equation:

$$\frac{d^2\psi}{dx^2} + 2\left(\frac{2\pi}{\lambda_c}\right)^2 \frac{E_{tot} - E_{pot}(x)}{hf_c}\psi = 0 \tag{2.56}$$

$$\frac{d^2\psi}{dx^2} + 2\frac{1}{r_c^2}\,\frac{E_{tot} - E_{pot}(x)}{hf_c}\psi = 0 \tag{2.57}$$

Solutions to the Schrödinger equation supposedly describe particle location probabilities which makes these two new variants more sensible than the original formulation because mass has been substituted with geometric quantities. Moreover the strange $\hbar^2$ term has vanished too and the energy term has been transformed into a dimensionless scaling term. It's also noteworthy that characteristic Compton particle model quantities can be incorporated naturally into the Schrödinger equation when it is expressed like in equation 2.56 & 2.57 which in turn supports the Compton particle model notion.

There is also one more noteworthy variant of the Schrödinger equation that features a $c\hbar$ term which is treated in more detail in section 4.1. Using equation 2.47 the term $\hbar^2$ in equation 2.54 can be replaced by $\hbar mcr_c$ which then gives the following neat variant of the Schrödinger equation which also utilizes the Compton radius:

$$\frac{d^2\psi}{dx^2} + 2\frac{1}{c\hbar}\frac{1}{r_c}[E_{tot} - E_{pot}(x)]\psi = 0 \tag{2.58}$$

Please note that the $c\hbar$ term also appears in gravitational and electromagnetic force equations after reformulating them (see equation 3.28, 4.10 and 4.20)

This first attempt of combining the Compton particle model with the the Schrödinger equation seems promising but two severe conceptual issues remain:

1. The Compton particle model treats particles as spheres with definite spatial properties whereas the Schrödinger equation supposedly describes particles in terms of waves and positional probabilities. This is another expression of the well known particle/wave duality problem of quantum physics.

2. Exited states of an electron which is bound to a proton do not exhibit spherical symmetry according to solutions of the Schrödinger equation but the Compton particle model can only deal with spherical particles.

The Compton particle model approves quantum physical uncertainty of position as a real phenomenon (see section 3.16) but this does not solve issue one. A reconciliation of issue one could be achieved by either adopting the so called pilot wave theory (14) or by choosing/finding another interpretation for the Schrödinger equation which does not involve positional probabilities. In fact Mills thinks that the probability interpretation of quantum physics is improper and he substantiates his thinking by explaining the famous double slit experiment in a different way. According to Mills the two slits interact with incoming particles electromagnetically so that induced currents in the slit material lead to an electromagnetic interaction which produces the observed interference pattern on a screen behind the slits. Mills also provides a detailed description in his book (4) and a more illustrative explanation is available on a website of his company Brilliant Light Power*.
Note: not all aspects of the theory provided by Mills fit with the Compton particle model. In particular Mills claims that free electrons have disc like shapes whereas electrons bound to atoms have spherical shells and moreover electrons have infinitely thin shells in his model.

Issue two will not be discussed here because a solution is proposed in the next section.

2.10 HYDROGEN

Only free Compton particles have been treated before and this section will make a first attempt at evaluating how Compton particles can form atoms by examining the simplest atom: hydrogen. Thieme suggested that hydrogen forms when an electron absorbs a proton into its centre to form a compound particle (1) which is possible in the Compton particle model since it considers Compton particles to be penetrable objects. After combining into hydrogen the electron radius is no longer determined by light speed (see equation 2.4) and instead the equilibrium of electrostatic attraction between proton & electron in opposition to centrifugal force determines the electron's radius. This force equilibrium can be approximated by treating the electron as a particle in orbit around the proton which can be expressed by the following equation

$$m_e \frac{v_t^2}{d} = m_e a_e \tag{2.59}$$

whereby m_e denotes electron mass, v_t denotes the electron's tangential velocity, d is the separation distance between proton & electron and a_e is the electric acceleration that keeps the electron in orbit. Using equation 4.11 to substitute a_e and dividing by electron mass m_e gives:

$$\begin{aligned} \frac{v_t^2}{d} &= \frac{r_{ce} c^2 \alpha}{d^2} \\ v_t^2 &= \frac{r_{ce}}{d} c^2 \alpha \end{aligned} \tag{2.60}$$

The conventional radius of hydrogen in its ground state is given by the so called Bohr radius a_0 (see equation 2.7) which will simply be used here without deriving it as it is confirmed by various experiments. Setting distance d in equation 2.60 to a_0 and using equation 2.8 to substitute r_{ce}/a_0 by α gives the following equatorial ring velocity for hydrogen:

$$v_{hy} = c\alpha = 2.187\,691 \times 10^6 \text{ m/s} \tag{2.61}$$

This velocity is also known as orbital velocity of the classical Bohr atom model for hydrogen. Thieme and Mills also calculated this velocity with different calculation approaches. Using the equatorial ring velocity v_{hy} the associated frequencies of hydrogen in its ground state can be stated as follows:

$$\omega_{hy0} = \frac{v_{hy}}{d} = \frac{c\alpha}{r_{ce}/\alpha} = \frac{c}{r_{ce}}\alpha^2 = \omega_{ce}\,\alpha^2 \tag{2.62}$$

$$f_{hy0} = \frac{\omega_{hy0}}{2\pi} = \frac{c}{2\pi r_{ce}}\alpha^2 = f_{ce}\,\alpha^2 \tag{2.63}$$

whereby ω_{ce} denotes the angular Compton frequency of the free electron and f_{ce} denotes the corresponding Compton frequency. Interestingly the last two equations exhibit a $\alpha^2 = 0.0000532514...$ term which is also present in the definition of the so called Rydberg constant

$$R_\infty = \frac{1}{2}\frac{\alpha^2}{\lambda_{ce}} = \frac{1}{4\pi}\frac{\alpha^2}{r_{ce}} = \frac{1}{4\pi}\frac{\alpha}{a_0} \tag{2.64}$$

* http://brilliantlightpower.com/double-slit

whereby λ_{ce} denotes the Compton wavelength of the free electron. Using equations 2.5, 2.62 and 2.63 to substitute λ_{ce} in equation 2.64 the Rydberg constant can also be expressed in terms of frequency:

$$R_\infty = \frac{1}{2}\frac{f_{ce}\,\alpha^2}{c} = \frac{1}{2}\frac{f_{hy0}}{c} = \frac{1}{4\pi}\frac{\omega_{hy0}}{c} \tag{2.65}$$

Actually the Rydberg constant can be written in many different ways but only the Compton particle model provides actual physical meaning to it. As observed by Thieme the α^2 term is related to the difference in properties between a free electron and one bound in hydrogen (1): one α is related to the electron's radius contraction as stated in equation 2.8 and one α is due to the rotational slowdown as described by equation 2.61.

Using equation 2.65 hydrogen's potential ground state energy can be expressed in terms of frequency:

$$E_{hy0\_pot} = -2R_\infty hc = -hf_{hy0} = -hf_{ce}\,\alpha^2 = -27.2\,\text{eV} \tag{2.66}$$

Please note that expressing hydrogen's potential energy in this way seems to be novel and again highlights the general relevance of hf terms. For excited states of hydrogen the equatorial ring speed v_{hy} doesn't change with radius whereas hydrogen's radius is given by $r_{hy} = a_0\,n^2 = r_{ce}\,n^2/\alpha$ for a orbital number n. Hydrogen's higher energy levels are then defined by $E_{pot\_hy} = -hf_{hy} = E_{pot\_hy0}/n^2$ whereby $f_{hy} = f_{hy0}/n^2 = c\alpha^2/(\lambda_{ce}n^2)$ denotes the associated rotational frequency for an excited state with orbital number n. Subsequently hydrogen's potential energy for arbitrary radii can be stated in the following ways:

$$E_{hy\_pot} = -hf_{hy} = -hf_{ce}\frac{\alpha^2}{n^2} = -m_e c^2\frac{\alpha^2}{n^2} = -\frac{c\hbar}{r_{ce}}\frac{\alpha^2}{n^2} = -\frac{ch}{\lambda_{ce}}\frac{\alpha^2}{n^2} = -\frac{c\hbar\alpha}{r_{hy}} \tag{2.67}$$

Please note that the last equation can also be retrieved by solving the Schrödinger equation for hydrogen which is further evidence for a connectedness between the Schrödinger equation and the Compton particle model.

The results presented in this section suggest that the Compton particle model is extendable to the hydrogen case but there is a serious conceptional conflict remaining which was already mentioned in section 2.9: contemporary physics claims that the electron is point like and in excited hydrogen states its positional presence probabilities as predicted by the Schrödinger equation do not exhibit spherical symmetry. Both of these notions do not fit with the Compton particle model which assumes that a spherical electron with real spatial extend absorbs a proton to create a spherical compound particle which is known as hydrogen. Fortunately Mills already provides an interesting concept that may resolve this issue: he claims that for a bound electron the Schrödinger equation describes a spherical harmonic and time harmonic current density that is confined to the two-dimensional surface of a sphere with fixed radius (4). The following image visualizes both interpretations which makes the conceptional difference easier to understand:

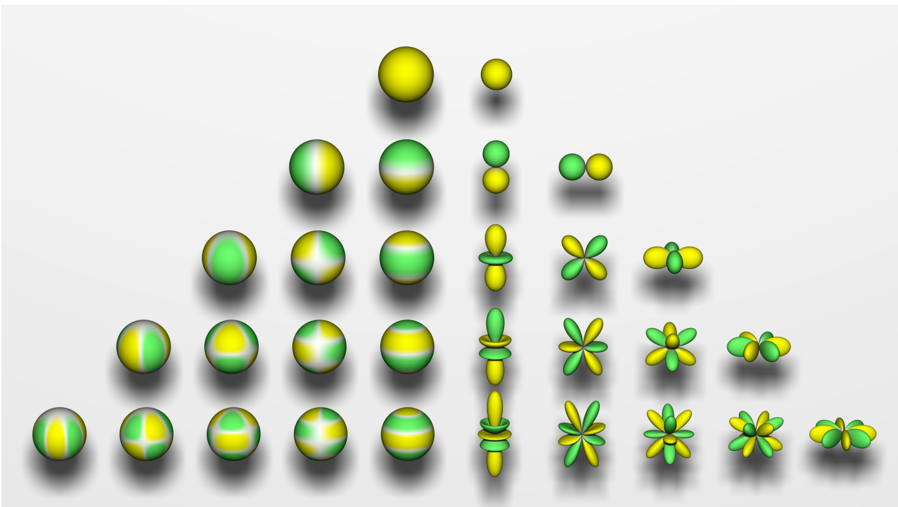

Figure 6: Spherical harmonics*. Current distributions (left) and positional probabilities (right).

Using this conception of Mills an electron remains spherical in excited hydrogen states and the properties that change are radius, rotation frequency and current distribution. This notion is expected to be compatible with the Compton particle model and it should also preserve various predictions of contemporary quantum physics in the context of hydrogen.

Please note that the magnetic moment of a bound electron and a free electron are identical since the involved α^2 terms cancel out. Using equation 2.19, which was derived for a free electron, also gives the expected value of one Bohr Magneton for the hydrogen case.

$$M_{hy} = ef_{hy0} \times \pi a_0^2 = ef_{ce}\alpha^2 \times \pi r_{ce}^2/\alpha^2 = ef_{ce} \times \pi r_{ce}^2 = M_B \tag{2.68}$$

3 QUANTUM GRAVITY

Haramein introduced a concept called holographic mass in his paper "Quantum Gravity and the Holographic Mass" (2) which will be examined in the sections below. In "The electron and the holographic mass solution" (3) Haramein gives a short overview of contemporary science in the field of holographic physics, how this branch of physics has started & evolved in the context of black hole thermodynamics and how the published papers helped him formulating the holographic mass concept. The most influential concept he built on was the so called holographic principle which states that the information inside a certain volume is also simultaneously present on the surface of that volume (5). This principle led him to the conjecture that mass depends on the information ratio of a volume and its enclosing surface. To calculate that quantity for a spherical object Haramein introduced the "Planck Spherical Unit" (PSU) and defined the information ratio as the ratio of PSUs that can be placed on a sphere's surface and inside its volume. Notably Haramein got sensible results when he applied his holographic mass concept to black holes and protons (2) which is a remarkable achievement because it connects two scientifically distinct domains that defied unification before.

Stongly correlated with the property of mass is the topic of gravitational force and some of Erik Verlinde's work will be presented in the following sections to introduce the notion of emergent gravity. This concept regards gravity as an emergent phenomenon which arises from entropic effects and Erik Verlinde was able to derive Newton's law of universal gravitation from entropic considerations on black holes (6). Another noteworthy conjecture of Verlinde's research is that on galactic scales gravity deviates from Newtonian gravity and should morph from a $1/r^2$ law to a $1/r$ law (7). This transition might explain the rotational motion of galactic discs which currently can only be explained by assuming the presence dark matter. A first experimental survey using weak gravitational lensing showed that Verlinde's emergent gravity theory fits with the collected data but further tests were deemed necessary by the involved researchers (8).

Moreover the following sections are going to demonstrate that the models of Haramein and Verlinde are interconnected with each other and the Compton particle model.

3.1 PLANCK SPHERICAL UNIT (PSU)

The PSU as defined by Haramein is spherical, has a radius of one half Planck length and a mass of one Planck mass. This document will also utilize the Planck Spherical Unit (PSU) but the PSU radius is changed to one Planck length for reasons that will become apparent later. Furthermore it is proposed that Haramein's PSUs and Thieme's dipoles are similar entities - Thieme's dipoles presumably consist of two PSUs which also implies that PSUs have a positive or negative charge. Also for reasons which become apparent later the PSU charge is defined to equal the unshielded Compton particle charge. Expressing these definitions as equations:

$$\text{PSU radius: } l_l = \sqrt{\frac{\hbar G}{c^3}} = 1.616\,23 \times 10^{-35}\ \text{m} \tag{3.1}$$

$$\text{PSU mass: } m_l = \sqrt{\frac{\hbar c}{G}} = 2.176\,47 \times 10^{-8}\ \text{kg} \tag{3.2}$$

$$\text{PSU charge: } \pm q_l = \pm\sqrt{2\epsilon_0 hc} = \pm 1.875\,55 \times 10^{-18}\ \text{C} \tag{2.38}$$

A PSU mass of one Planck mass seems to be unreasonably high for the smallest building block of our universe and this probably is one of the main reasons why the Planck units are usually considered to be an arbitrary system of units. The following sections will demonstrate though that this PSU mass is actually a sensible value and how it fits into the larger picture.

Moreover the PSUs are also assumed to be the building blocks of space itself which results in polarizability of space. Although individual PSUs possess charge the vacuum is charge neutral overall because there should be an equal amount of positively and negatively charged PSUs in space. Locally subtle deviations could be possible which might be responsible for what contemporary physics calls virtual particles.

3.2 HOLOGRAPHIC MASS

The following sections will use the same symbols, or at least similar ones, as used by Haramein in (2) to avoid confusion for readers of both papers. Though as mentioned before the PSU radius is different from Haramein's original definition and there are also some differences in proportionality constants as pointed out later.

The notion of an information ratio was already brought up in the Quantum Gravity introduction section and it is now formalized here. The measure of information for a sphere's surface is defined as the surface area of a sphere divided by the area that a great circle encloses on a PSU:

$$\eta = \frac{4\pi r^2}{\pi l_l^2} = 4\left(\frac{r}{l_l}\right)^2 \tag{3.3}$$

The measure of information for a sphere's volume is defined as the sphere's volume divided by the volume of a PSU:

$$R = \frac{4\pi r^3/3}{4\pi l_l^3/3} = \left(\frac{r}{l_l}\right)^3 \tag{3.4}$$

These measures of information can then be used to define a characteristic information ratio:

$$\phi_h = \frac{1}{4}\frac{\eta}{R} = \frac{l_l}{r} = \frac{1}{r/\,l_l} \tag{3.5}$$

The factor of $1/4$ is actually a fudge factor for now and it also differs from Haramein's original definition where it had a different value and was part of equation 3.6 instead of equation 3.5. The fudge factor issue will be revisited in section 3.8 which is why it will not be discussed in more detail here. Furthermore the astute reader may wonder about the packing scheme of the spherical PSUs and the space between them - this topic will also be addressed in depth in section 3.8.

Haramein discovered that he could calculate black hole mass by using the information ratio ϕ_h, the Planck mass and the black hole radius. Because of the concepts that led him to this insight he called the associated equation the holographic mass equation. However this section will treat the related fundamental particle case first. Haramein showed that it is also possible to calculate the proton mass by simply multiplying the information ratio ϕ_h with the Planck mass and this relationship is referred to as the inverse holographic mass $m_\hbar$ from now on.

$$m_\hbar = \phi_h\, m_l = \frac{l_l}{r_c} m_l = \frac{1}{r_c/\,l_l} m_l \tag{3.6}$$

The word inverse is used here since the particle radius appears in the denominator of the last equation. Please note that the term $r_c/\,l_l$ denotes the quantized particle radius which is sensible for a quantum physical treatment of mass. Moreover using equations 3.1 and 3.2 the inverse holographic mass can also be expressed as follows:

$$m_\hbar = \frac{1}{r_c}\sqrt{\frac{\hbar G}{c^3}}\sqrt{\frac{\hbar c}{G}} = \frac{1}{2\pi r_c}\frac{h}{c} = \frac{1}{r_c}\frac{\hbar}{c} \tag{3.7}$$

Astonishingly the last equation is equal to the Compton particle equation 2.11 which is why the Compton radius r_c was already used in the two previous equations. Moreover this equality establishes the connectedness of the Compton particle model with Haramein's thinking as already anticipated in section 2.8. Moreover the connection is also reflected by the presence of the Compton particle circumference $2\pi r_c$ in equation 3.7.

Please also note that the gravitational constant G is absent from equations 3.6 and 3.7 which are also remarkably simple. This absence will be encountered again and examined in more detail in the upcoming sections. But it is also possible to express the holographic mass equation in terms of the gravitational constant G by using equation 3.1:

$$m_\hbar = \frac{l_l^2\, c^2}{r_c\, G} \tag{3.8}$$

This expression is reminiscent of how black hole mass is usually stated since it features a c^2/G term and thus the last equation constitutes the first hint for a correlation between the inverse holographic mass and black hole mass.

The appropriate radii for inverse holographic mass equations are the Compton particle radii as stated in table 1 of section 2.2. That section also mentioned that the proton radius deviation from the conventional radius is close to a factor of $1/4$ which encourages the following modification: removing the $1/4$ factor from equation 3.5 would make the inverse holographic mass compatible with the standard model of physics, i.e. the conventional proton radius could be used to calculate the proton mass from the inverted holographic mass equations. Doing so might be correct but there are symmetry and topology relationships in the upcoming sections which suggest that this would be inappropriate (in particular equation 3.54 and 3.55).

3.3 BLACK HOLES

The mass equation for Schwarzschild black holes is given by

$$m_s = \frac{1}{2}\frac{r_s c^2}{G} \tag{3.9}$$

whereby r_s denotes the black hole's radius. As Nassim showed in (2) it is also possible to express equation 3.9 in terms of ϕ_h when rearranging it using equation 3.1 and 3.2:

$$m_s = \frac{1}{2}\frac{1}{\phi_h}m_l = \frac{1}{2}\frac{r_s}{l_l}m_l = \frac{1}{2}\frac{r_s}{\sqrt{\frac{\hbar G}{c^3}}}\sqrt{\frac{\hbar c}{G}} = \frac{1}{2}\frac{r_s c^2}{G} \tag{3.10}$$

The Schwarzschild mass as expressed in the last equation is very similar to the inverted holographic mass as stated in equation 3.6 which is a remarkable link between the extremely small and the extremely large. These equations only differ by a factor of $1/2$ and ϕ_h is used in an inverse manner whereby the latter constitutes an intriguing symmetry feature. Please note that it is the inverted use of ϕ_h which causes the different mass scaling behaviour: Schwarzschild black holes, which are essentially accumulations of Compton particles, possess mass that scales proportional to radius r whereas Compton particle mass scales proportional to $1/r$.

The revealed symmetry indicates that the holographic mass concept has merit but the Schwarzschild black hole is probably not be the appropriate symmetry partner for a Compton particle because this class of black holes does not possess rotation. The black hole type that also incorporates rotation is a Kerr black hole and the appropriate Compton particle symmetry partner is presumably a Kerr black hole that also spins with light speed c at the edge of its equatorial plane like a Compton particle does. Such a Kerr black hole has the following radius relationship to a Schwarzschild black hole of the same energy (10)

$$r_s = 2r_k \tag{3.11}$$

and an angular frequency of:

$$\omega_k = \frac{c}{r_k} \tag{3.12}$$

This document will only consider Kerr black holes with an angular frequency of ω_k and refer to them as extreme Kerr black holes.

Inserting equation 3.11 into equation 3.10 gives the mass equation for extreme Kerr black holes:

$$m_k = \frac{r_k c^2}{G} \tag{3.13}$$

The last equation can also be expressed in terms of ϕ_h and m_l:

$$m_k = \frac{1}{\phi_h}m_l = \frac{r_k}{l_l}m_l = m_h \tag{3.14}$$

Equation 3.14 and 3.6 are apparently very similar: the only remaining difference is the inverted use of the ϕ_h term. Haramein used equation 3.10 for the definition of holographic mass but because of the better symmetry this document uses equation 3.14 as the definition of holographic mass m_h. Using equation 3.1 it is also possible to express m_k without the gravitational constant G which gives an holographic mass equation that is more similar to equation 3.7:

$$m_k = \frac{\hbar}{c}\frac{r_k}{l_l^2} = \frac{\hbar}{l_l^2\,\omega_k} = m_h \tag{3.15}$$

Another noteworthy symmetry appears when comparing the energy equations of extreme Kerr black holes and Compton particles. Using equation 3.14 the energy of an extreme Kerr black hole can be expressed as follows

$$E_k = m_k c^2 = \frac{r_k m_l}{l_l} c^2 = \frac{r_k}{c}\frac{c}{l_l} m_l c^2 = E_l \frac{\omega_l}{\omega_k} \tag{3.16}$$

whereby E_l denotes the Planck energy $m_l c^2 = \hbar\omega_l$ and ω_l denotes the angular Planck frequency c/l_l. The energy of a Compton particle can be expressed in a similar fashion using equation 2.6 :

$$E_c = m_\hbar c^2 = \hbar\omega_c = \hbar\omega_l \frac{\omega_c}{\omega_l} = E_l \frac{\omega_c}{\omega_l} \tag{3.17}$$

The symmetry between E_k and E_c is further evidence for the similarity of Compton particles and black holes but this similarity only becomes apparent when utilizing the Planck units. A question that remains though is if the appropriate Compton particle symmetry partner should also possess charge and if so how much of it?

The ϕ_h function can also be used to form a direct relationship between extreme Kerr black hole mass and inverse holographic mass:

$$m_k \phi_h^2 = m_\hbar = m_h \phi_h^2 \tag{3.18}$$

Though this relationship should just be of hypothetical relevance since it is impossible for a black hole to possess the radius of any of the existing Compton particles though there is one known exception as explained in section 3.5 and curiously there is also a numerical oddity when applying the proton's Compton radius r_{cp} to the black hole mass equations:

$$\begin{aligned} m_s(r_{cp}) &\cong \sqrt{2} \times 10^{11}\ \text{kg} \\ m_k(r_{cp}) &\cong 2\sqrt{2} \times 10^{11}\ \text{kg} \end{aligned} \tag{3.19}$$

The deviation of these results is less than 0.13% which is quite high for a result in particle physics and therefore this numerical oddity might be dismissed but more $\sqrt{2}$ terms appear throughout this document which suggests that there is some underlying physical cause.

3.4 SCHRÖDINGER EQUATION

This section will demonstrate that the time independent Schrödinger equation also yields interesting variants when adopting it for black holes. To accomplish this the $2m/\hbar^2$ term has to be rearranged using equation 2.47, 3.1, 3.9 and 3.11:

$$\frac{2m}{\hbar^2} = \frac{2m}{m_l^2\, l_l^2\, c^2} = \frac{r_s}{m_l^2\, l_l^2\, G} = \frac{r_s}{m_l^2\, l_l^2} \frac{m_l}{l_l c^2} = \frac{r_s}{V_l}\frac{1}{E_l} = 2\frac{r_k}{V_l}\frac{1}{E_l} \tag{3.20}$$

Here V_l denotes the cubic Planck volume l_l^3 and E_l denotes the Planck energy $m_l c^2$. Putting the last equation into equation 2.54 then gives:

$$\frac{d^2\psi}{dx^2} + 2\frac{r_k}{V_l}\frac{E_{tot} - E_{pot}(x)}{E_l}\psi = 0 \tag{3.21}$$

Similar to equation 2.56 and 2.57 the energy term reduces to a dimensionless scaling term and all other fractions in equation 3.21 have the unit of length in various powers - which is a sensible trait for the Schrödinger equation. The Planck volume V_l also makes sense here since the Schrödinger equation is concerned with three dimensional space though equation 3.21 just treats the x component. Moreover it is noteworthy that Planck units appear in the Schrödinger equation in a sensible way when adopting it for black holes which is further evidence for the connectedness of the very large and the very small and that this connection involves the Planck units.

3.5 PSU RELATIONSHIPS

This section will explore the relationships of Planck Spherical Units (PSUs) to other quantities and already the first equation of this section demonstrates a remarkable relationship between a PSU's Planck mass m_l and holographic mass:

$$m_\hbar(l_l) = m_h(l_l) = m_l \tag{3.22}$$

According to the last equation PSUs are Compton particles and black holes at the same time and therefore the PSU, with its radius of one Planck length l_l, constitutes a kind of nexus point between the very small and the very large. This again demonstrates that Planck length and Planck mass are key properties of our universe and the conspicuously high value of the Planck mass (see equation 3.2) begins to make sense. In public talks Haramein often stated that for conceptual reasons our universe should be built from black holes which is what the last equation essentially states since even space itself is suspected to be built from PSUs that qualify as black holes. Moreover the uniqueness of the PSU's Planck mass can also be expressed by multiplying the inverse holographic mass with holographic mass which results in a geometric mean equation that is valid for arbitrary radii r:

$$m_l = \sqrt{m_h(r)\, m_\hbar(r)} \tag{3.23}$$

Knowing that PSUs are also Compton particles allows using equation 2.3 to calculate the Compton frequency of a PSU:

$$f_l = \frac{c}{2\pi\, l_l} = 2.952\,147 \times 10^{42}\ \text{Hz} \tag{3.24}$$

Multiplying f_l by 2π yields the angular frequency for PSUs which matches the angular Planck frequency ω_l:

$$\omega_l = 2\pi f_l = \frac{c}{l_l} = 1.854\,888 \times 10^{43}\ \text{rad s}^{-1} \tag{3.25}$$

Please note that no object should be able to rotate faster than a PSU since the angular Planck frequency is expected to be the upper limit for angular frequency in our universe.
Like for any other Compton particle the product of Planck's constant with the Compton frequency yields the particle's energy, i.e. $E_l = hf_l$. But since the PSU is too small to have self energy contributions linked to internal Compton particle polarization as described in section 2.7 PSUs should be regarded as pure energy which has condensed into small "drops". At the fundamental level energy and rotation should be synonymous because there is no "substance" involved in PSU rotation which we could measure from within our universe or divide and thus PSU rotation should be regarded as immaterial but energetic. In this line of thinking energy is even more fundamental than mass and Planck's constant h is only required for translating fundamental rotation to the conventional energy unit Joule which is also used for translational motion.

Nonetheless an equivalent PSU mass $m_l = E_l/c^2$ can be calculated which is of practical use. For example the gravitational constant G can also be expressed in terms of Planck mass which allows expressing gravitational force with respect to the PSU mass.

$$G = \frac{l_l c^2}{m_l} = \frac{c\hbar}{m_l^2} \tag{3.26}$$

$$F_g = a_g\, m = \frac{l_l c^2}{d^2} \frac{mM}{m_l} \tag{3.27}$$

$$F_g = a_g\, m = \frac{c\hbar}{d^2} \frac{mM}{m_l^2} \tag{3.28}$$

Here the variables m and M just denote two different and arbitrary masses. Please note that the $c\hbar/d^2$ term in equation 3.28 has the units of acceleration and the fraction which is involving masses is dimensionless whereas for the special case of two Compton particles this ratio can also be expressed in different ways as shown by the next equation. There r_{cm}, r_{cM}, f_{cm} and f_{cM} denote the Compton radius and Compton frequency of mass m and M respectively.

$$\frac{mM}{m_l^2} = \frac{1}{r_{cm}\, r_{cM} / \, l_l^2} = \frac{f_{cm} f_{cM}}{f_l^2} \tag{3.29}$$

Please note that all fractions in the last equation denote dimensionless scaling terms as all variables get quantized by their appropriate Planck unit. Moreover the last three equations demonstrate that the gravitational constant G and mass are not unavoidable for expressing gravitational force in the Compton particle model.
For completeness it is shown here that the gravitational force can also be expressed in terms of the so called Planck force $F_l = c\hbar/l_l^2$:

$$F_g = F_l \frac{1}{d^2/\, l_l^2} \frac{mM}{m_l^2} \tag{3.30}$$

Expressing gravitational force in this way is interesting because mass and distance both get divided by their respective Planck unit which creates two dimensionless scaling terms. The meaning of the Planck force will be treated in more detail in section 4.1.

3.6 POTENTIAL ENERGY

The gravitational potential energy $U_g = -GmM/r$ can be used to describe the self energy of Compton particles and black holes according to

$$E_c = G\frac{m_l^2}{r_c} \tag{3.31}$$

$$E_k = Gr_k\frac{m_l^2}{l_l^2} \tag{3.32}$$

which is analogous to what was already discovered in the electric potential energy case (see equation 2.41). This analogy also indicates that 50% of a Compton particle's self energy is electric in nature and 50% is gravitational which implies that the assessment on self energy as presented in section 2.7 might have to be reconsidered. Furthermore this finding again highlights the relevance of the Planck units and is in line with what gets presented in the section 3.13 which examines the strong force.

Based on equation 3.28 the gravitational potential energy can also be expressed as follows:

$$U_g = -\frac{c\hbar}{d}\frac{mM}{m_l^2} \tag{3.33}$$

Interestingly it's possible to express the last equation as pure hf term when adopting it for Compton particles. To achieve that distance d must also be converted to a frequency which is easily done by defining the following relationship:

$$\omega_d = 2\pi f_d = \frac{c}{d} \tag{3.34}$$

Using the last equation and equation 3.29 the gravitational potential energy for two Compton particles can then be expressed as follows:

$$U_{gcc} = -hf_d\frac{f_{cm}\,f_{cM}}{f_l^{\,2}} \tag{3.35}$$

This relationship again highlights that hf terms do not apply exclusively to photons and it also raises the question if gravity is related to Compton particle rotation.
The validity of the last equation can be checked by taking its derivative with respect to distance:

$$F_{gcc} = \frac{\mathrm{d}\,U_{gcc}}{\mathrm{d}d} = -h\frac{f_{cm}\,f_{cM}}{f_l^{\,2}}\frac{\mathrm{d}\,f_d}{\mathrm{d}d} = \frac{c\hbar}{d^2}\frac{f_{cm}\,f_{cM}}{f_l^{\,2}} \tag{3.36}$$

As expected an equation for gravitational force is retrieved which is a variant of equation 3.28.

3.7 ENTROPIC GRAVITY - PART ONE

Verlinde theorized that gravity might be an emergent force whose true origin comes from entropy. He arrived at this notion by considerations that involved the holographic principle (5) and black hole thermodynamics. In (6) Verlinde demonstrated that it is indeed possible to retrieve Newtonian gravity from entropic considerations and a compact recapitulation is given in this section.

Verlinde first set a measure for information inspired by concepts which were proposed earlier in the context of black hole thermodynamics research. He assumed that the amount of information N on a sphere with radius r is given by how many Planck length sized squares can be put on the corresponding surface A whereby each such square equals one bit.

$$N = \frac{A}{l_l^2} = \frac{4\pi r^2}{l_l^2} = \frac{4\pi r^2 c^3}{G\hbar} \tag{3.37}$$

Verlinde also reasoned that Schwarzschild black holes should be in thermal equilibrium and that their entropy is evenly distributed on their spherical surface. Then the equipartition theorem should apply which is given by

$$E = \frac{1}{2}NT_s k_b \tag{3.38}$$

whereby k_b denotes the Boltzmann constant with a value of $1.380\,649 \times 10^{-23}$ J/K and T_s denotes the temperature at the black hole horizon for a Schwarzschild black hole with mass energy

$$E = m_s c^2 \tag{3.39}$$

and a horizon temperature as given by the Hawking temperature:

$$T_s = \frac{\hbar c^3}{8\pi G m_s k_b} \tag{3.40}$$

As Unruh showed in (9) an observer in vacuum with constant acceleration a will experience the following temperature:

$$T_u = \frac{\hbar a}{2\pi k_b c} \tag{3.41}$$

It's possible to replace acceleration a by F_g/m whereby m denotes the mass of a comparatively small particle that is located close to the black hole horizon and attracted with force F_g. Doing so gives:

$$T_u = \frac{\hbar}{2\pi k_b c}\frac{F_g}{m} \tag{3.42}$$

The radius of the Schwarzschild black hole horizon is given by $r_s = 2m_sG/c^2$ (equation 3.9) and using gravitational acceleration a_g (equation 3.43) the gravitational acceleration a_s of mass m is given by:

$$a_g = GM/r^2 \tag{3.43}$$

$$a_s = Gm_s/r_s^2 = c^4/(4m_sG) \tag{3.44}$$

Interestingly this leads to the following equality at the Schwarzschild black hole horizon:

$$T_s = T_u(a = a_s) \tag{3.45}$$

Thus T_s can be replaced by the Unruh temperature (equation 3.42) in equation 3.38. Also inserting equation 3.37 & 3.39 into equation 3.38 and subsequent rearranging for F_g then results in the equation for Newtonian gravity:

$$\begin{aligned} m_sc^2 &= \frac{1}{2}\frac{4\pi r^2 c^3}{G\hbar}k_b\frac{\hbar}{2\pi k_b c}\frac{F_g}{m} \\ F_g &= G\frac{m_s m}{r^2} \end{aligned} \tag{3.46}$$

This is a remarkable result that also highlights the importance of the Planck length and its connection to fundamental information.

Furthermore Verlinde showed in public talks that the second law of thermodynamics can also be retrieved from black hole thermodynamics as originally proposed by Ted Jacobson (13). For a Schwarzschild black hole the rate of change of mass M_s with area A_s as derived from general relativity theory is given by

$$\frac{\mathrm{d}M_s}{\mathrm{d}A_s} = \frac{1}{2\pi}\frac{a}{4G} \tag{3.47}$$

whereby a denotes the gravitational acceleration at the horizon. Furthermore the entropy of a Schwarzschild black hole is given by the so called Bekenstein-Hawking entropy (11):

$$S_s = k_b\frac{A_s}{4l_l^2} = k_b\frac{4\pi r_s^2}{4l_l^2} = k_b\frac{\pi r_s^2}{l_l^2} \tag{3.48}$$

Inserting equation 3.41 and the derivative of equation 3.48 with respect to A_s into equation 3.47 gives:

$$\begin{aligned} \mathrm{d}M_s &= \frac{1}{2\pi}\frac{a}{4G}\,\mathrm{d}A_s \\ \mathrm{d}M_s &= \frac{1}{2\pi}\frac{2\pi k_b c T_u}{\hbar 4G}\frac{4l_l^2\,\mathrm{d}S_s}{k_b} \\ \mathrm{d}M_s &= \frac{cl_l^2}{\hbar G}T_u\,\mathrm{d}S_s \end{aligned} \tag{3.49}$$

Using equation 3.1 to substitute l_l^2 the last equation reduces to the second law of thermodynamics for a reversible process

$$\mathrm{d}M_sc^2 = \mathrm{d}E_s = T_u\,\mathrm{d}S_s \tag{3.50}$$

and it was this relationship which initially sparked the conjecture that gravity is actually emerging from thermodynamics and entropy.

As mentioned before the ideas behind the entropic gravity notion and the holographic mass concept have the same origin and comparing equations 3.3, 3.37 & 3.48 reveals their connection:

$$N = \pi\eta = 4S_s/k_b \tag{3.51}$$

Here the factor π denotes the area conversion factor between circles with a radius of one Planck length and squares with a side length of one Planck length but since N and η are presumably quantities of information the factor π seems to be inappropriate here and therefore this relation is examined further in the next section.

3.8 PSU TOPOLOGY

The factor π in equation 3.51 may indicate that the topology used for the holographic mass concept, as outlined in section 3.2, is not the 100% correct one. A proportionality constant between N and η should be an integral number or a rational fraction since these quantities are assumed to be related to bits of information. Moreover the equations for counting PSUs which were presented in section 3.2 do not really explain how PSUs are packed in space. Assuming that the three dimensional view of space is still valid at the quantum level it would not be possible to stack PSUs as described by equation 3.3 and 3.4 because then the sphere packing scheme would be without gaps and without overlap. One possible answer to this issue is that at the quantum level of space such considerations are nonsensical because PSUs are space and there is no in between. But there may be other topologies that use the PSU properties as pointed out in section 3.1 and also retain the holographic mass equations. The aim of this section is to introduce one such alternative topology.

A first sensible assumption is that a fundamental object's spherical surface should be filled with PSUs that overlap just enough to fill all of the surface without gaps. To achieve this the whole surface must be divided into small squares which are all circumscribed by a PSU. Consequently these squares have side length $l_l\sqrt{2}$, a diagonal length of $2l_l$ and an area of $2l_l^2$. In case the area of one of these squares is considerably smaller than the sphere's surface area it is an appropriate approximation to simply divide areas to get the number of PSUs on the surface:

$$\eta_{sq} = \frac{4\pi r^2}{\left(l_l\sqrt{2}\right)^2} = \frac{4\pi r^2}{2l_l^2} = 2\pi\left(\frac{r}{l_l}\right)^2 \tag{3.52}$$

The following two images are visual representations of the last equation:

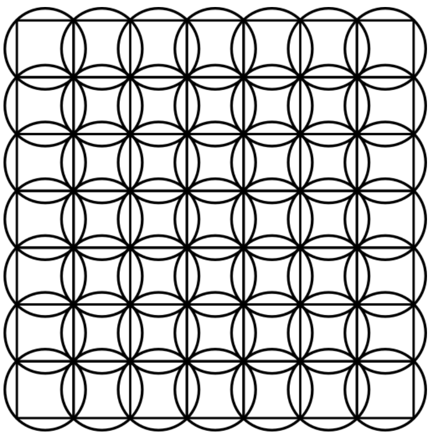

Figure 7: Surface pattern

Figure 8: Sphere of spheres

In numerous public talks Haramein suggested that the structure of space should be built from octahedrons in combination with tetrahedrons and he also proposed a possible structure which he labelled the "64 tetrahedron grid". As of now Haramein could not integrate this proposed structure into his work on the proton structure but the remainder of this section will show that his proposed structure can indeed be used as fundamental topology, i.e. applied to Compton particles, black holes and even space itself.

The following two figures depict the two geometries which will be relevant for the calculations done in this section whereby the octahedron size is determined by the enclosing PSU and the tetrahedron edge length matches that of the octahedron. The purpose of the octahedrons is to define the correct separation between individual PSUs.

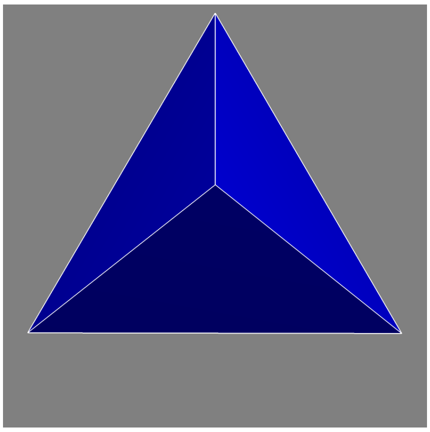

Figure 9: Tetrahedron

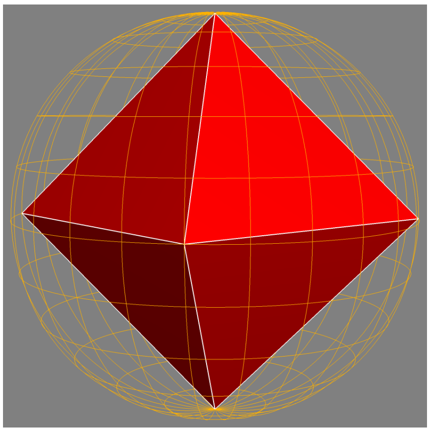

Figure 10: PSU enclosing octahedron

For easier recognition the colour theme used in the two figures above will be utilized throughout this document: tetrahedrons are depicted in blue and octahedrons are depicted in red. Please note that this colouring scheme is not related to electric charge.

Each octahedron has an edge length of $l_l\sqrt{2}$ so that it is enclosed by a PSU (see figure 10). Consequently an octahedron's cross section area along its edges is $2l_l^2$ which is identical to the square area used in equation 3.52. Because of that equivalence this particular octahedron size is a good choice for counting PSUs in 3D space but octahedrons alone are not space filling. As Buckminster Fuller explained two tetrahedrons and one octahedron of the same edge length are required to fill space without gaps (12). Using this knowledge the number of PSUs inside a sphere, which is substantially larger than an individual PSU, can be approximated by the following calculation that simply divides the sphere's volume by the volume of one octahedron and two tetrahedrons:

$$R_{oct} = \frac{4\pi r^3/3}{\frac{\sqrt{2}}{3}(\sqrt{2}l_l)^3 + 2\frac{\sqrt{2}}{12}(\sqrt{2}l_l)^3} = \frac{4\pi r^3/3}{\sqrt{2}\,l_l^3/2} = \frac{8\pi}{3\sqrt{2}}\left(\frac{r}{\sqrt{2}\,l_l}\right)^3 = \frac{2\pi}{3}\left(\frac{r}{l_l}\right)^3 \tag{3.53}$$

As already stated octahedrons and tetrahedrons together can fill all of space without gaps but they can also be stacked into larger octahedrons which constitutes a fractal relationship. Moreover as can be seen from the following two visualizations the proposed topology can also be regarded as only being constructed from equilateral triangles of identical size.

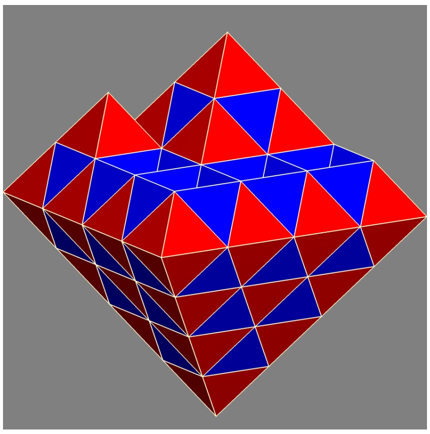

Figure 11: Stacked octahedrons

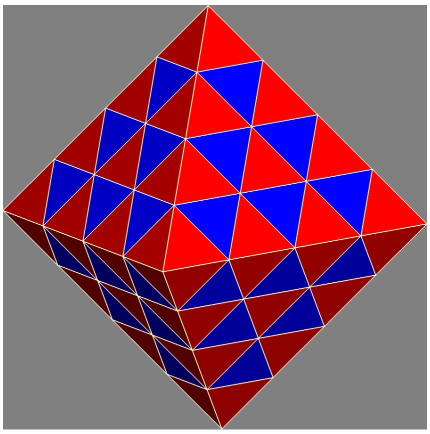

Figure 12: Fractal octahedron

The surface of a fractal octahedron exhibits a remarkable property because of its triangular composition - it encodes the so called "flower of life" pattern which is highlighted in figure 14. Please note that each yellow circle in figure 14 has a radius of $l_l\sqrt{2}$ which is different from the PSU radius which is one Planck length.

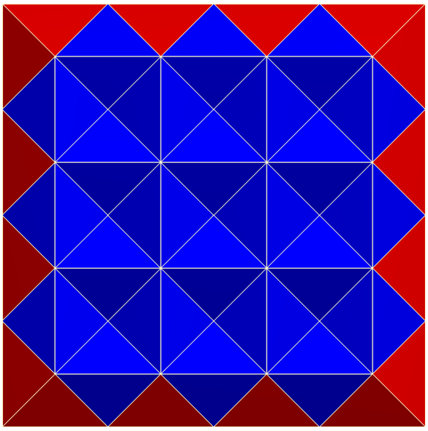

Figure 13: Pyramidal intake slots

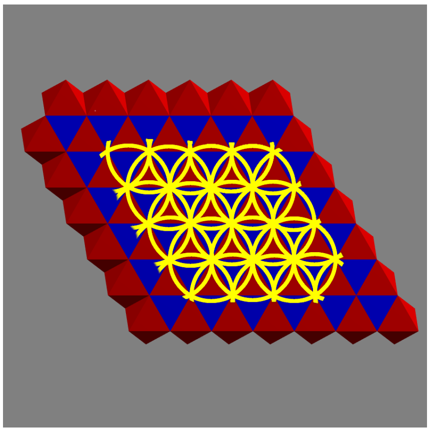

Figure 14: Flower of life pattern

Moreover octahedrons and tetrahedrons can also be combined to form fractal tetrahedrons as shown in figure 15:

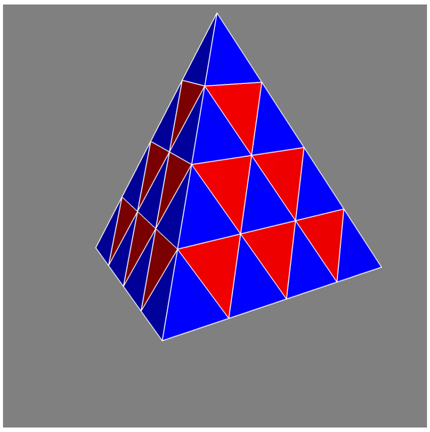

Figure 15: Fractal tetrahedron

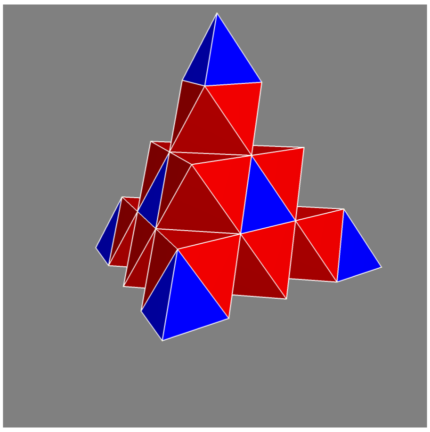

Figure 16: Fragmented tetrahedron

Having defined a new PSU topology it is now possible to express ϕ_h in an alternative way by using equation 3.52 and 3.53:

$$\phi_h = \frac{1}{3}\frac{\eta_{sq}}{R_{oct}} = \frac{l_l}{r} = \frac{1}{r/l_l} \tag{3.54}$$

In the last equation the proportionality constant has changed from $1/4$ to $1/3$ compared to equation 3.5 and the number 3 is actually a sensible value in this context. For spheres it is the proportionality constant of volume V_{sph} to surface area A_{sph} according to $A_{sph} = 3V_{sph}/r$ and rearranging this area to volume relationship makes the connection to ϕ_h more obvious:

$$\frac{1}{r} = \frac{1}{3}\frac{A_{sph}}{V_{sph}} = \frac{\phi_h}{l_l} \tag{3.55}$$

Consequently equation 3.54 should be regarded as the quantized version of equation 3.55 and thus ϕ_h represents a method to calculate the inverse of the quantized radius r/l_l from quantized volume R_{oct} and quantized area η_{sq}.

The PSU topology as presented in this section has a different relationship to the entropic gravity model which is reflected by the relationship of N to η_{sq}:

$$N = 2\,\eta_{sq} \tag{3.56}$$

This equation makes more sense than equation 3.51 since the factor π has been replaced by an integral number. But what is the role of the factor two? Assuming that a Planckian bit is given by l_l^2 the last equation states that each PSU contains two bits of information. PSUs are presumed to be equal in most of their internal properties and these two bits probably encode their differences. Possible candidates for these differences are spin $\uparrow\downarrow$ and positive / negative charge.

The thinking which led Haramein to the presented PSU topology was inspired by Richard Buckminster Fuller. In his book "Synergetics" Fuller noted that cuboctahedrons are the only platonic solid in "vector equilibrium" (12) which means that all internal vectors of a cuboctahedron cancel out. Haramein therefore concluded that the cuboctahedron should also be a part of the fundamental space-time geometry and actually the cuboctahedron is contained implicitly in the presented topology. Cutting the magenta colored octahedrons of figure 17 in half will produce the cuboctahedron of figure 18. The resulting cuboctahedron consists of six magenta coloured pyramids facing inwards and eight tetrahedrons in blue colour which are located between the pyramids.

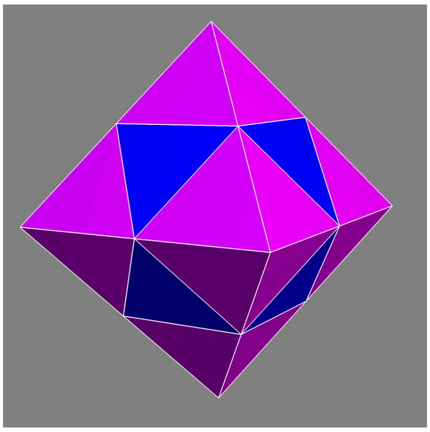

Figure 17: Group of six octahedrons

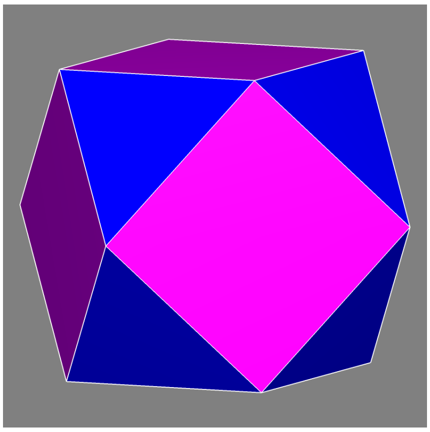

Figure 18: Cuboctahedron

Thus each group of six neighbouring octahedrons is embedded into a cuboctahedron structure which presumably provides the maximum possible stability and balance to space. Depending on the scale at which the PSU topology is examined it also features fractal octagons, fractal tetrahedrons and fractal cuboctahedrons of varying sizes which are all intertwined. Since the presented PSU topology also contains sheets of hexagonal geometry which are embedded into the three possible cross sections of the cuboctahedron along its edges the presented PSU topology might also be regarded as a hexagonal crystal or figuratively speaking as a stack of skewed honey combs.

Please note that the octahedron & tetrahedron lattice as presented in this section should not only describe the internal structure of Compton particles but also the structure of "empty" space and black holes. This lattice presumably provides the configuration space in which everything exists and particles should be regarded as dynamic patterns in this lattice. Moreover when a PSU or particle moves it does not "flow" in the common sense of an object moving through empty space but instead it is presumed that a sequence of distinct configuration changes takes place which appears like an object's continuous motion. This process should be comparable to what happens in computers where individual binary memory cells can change their information content in cyclic updates but still the grid of physical memory cells is static and hence this conception of space is also not a revival of the ether concept.

3.9 SECOND LAW OF THERMODYNAMICS

It was shown in section 3.7 that equation 3.47 leads to the second law of thermodynamics when using the Bekenstein-Hawking entropy S_s (equation 3.48) and the Unruh temperature T_u (equation 3.41) but ut equation 3.47 can be simplified further using equation 3.43 to get the following relationship for change of mass with area:

$$\frac{\mathrm{d}M}{\mathrm{d}A} = \pm\frac{1}{2\pi}\frac{a_g}{4G} = \pm\frac{1}{2}\frac{M}{A} \tag{3.57}$$

This relationship does not only apply to Schwarzschild black holes as delineated in section 3.7 but to extreme Kerr black holes and Compton particles as well. Please note that the $\pm$ symbol in the last equation denotes a minus for the Compton particle case and a plus in all other cases. This scheme will be used throughout this section.

Instead of using equation 3.43 the relationship described by the last equation can also be retrieved by derivation: M is $\propto \sqrt{A}$ for Schwarzschild black holes and extreme Kerr black holes. Then the derivative of M with respect to A is $\propto 1/(2\sqrt{A})$ but $M/(2A)$ is also $\propto 1/(2\sqrt{A})$. In the Compton particle case the situation is similar: M is $\propto 1/\sqrt{A}$ and the derivative with respect to A is $\propto -1/(2A\sqrt{A})$ as is $-M/(2A)$.

Section 3.7 showed that the Unruh temperature and the Hawking temperature are identical at a Schwarzschild black hole's radius. This correlation can be generalized further by introducing a new quantity: the gravitational temperature T_g. The gravitational temperature and the Unruh temperature are defined to be equal at any separation r in case the associated acceleration is caused by a single mass M according to Newtonian gravity:

$$T_g = T_u \left(a = \frac{GM}{r^2} \right) \tag{3.58}$$

Expressing the gravitational temperature can be done in a variety of ways using equation 3.1, 3.37, 3.48, 3.52 and $E = Mc^2$:

$$T_g = \frac{1}{2\pi k_b} \frac{\hbar}{c} \frac{GM}{r^2} = \frac{2G}{k_b} \frac{\hbar}{c} \frac{M}{A} = \frac{2Mc^2}{k_b} \frac{l_l^2}{A} = \frac{2E}{k_b} \frac{l_l^2}{A} = \frac{E}{k_b} \frac{l_l^2}{2\pi r^2} = \frac{2E}{k_b N} = \frac{E}{k_b \eta_{sq}} = \frac{1}{2} \frac{E}{S_s} \tag{3.59}$$

The presence of N, η_{sq} and S_s reveals the connection to black hole mass and holographic mass as described in previous sections. Therefore and because of how the gravitational temperature was defined it applies to Schwarzschild black holes, extreme Kerr black holes and Compton particles. Please note that the gravitational temperature will be used in two different ways and to avoid confusion the symbols T_{gv} and T_{gf} will be used to distinguish them when necessary. In the T_{gv} case mass & energy are both varying with radius r but in the T_{gf} case mass & energy are fixed and r must be interpreted as distance.
Examining the last equation shows that the gravitational temperature contains the equipartition theorem for one degree of freedom since individual bits denoted by the variable N can be considered as having one degree of freedom. A rearranged version of the last equation states the equipartition theorem in a more familiar way:

$$\frac{1}{2} N k_b T_g = \frac{1}{2} \frac{A}{l_l^2} k_b T_g = \eta_{sq} k_b T_g = E \tag{3.38}$$

In the entropic view of gravity the Hawking temperature T_s should be regarded as a special case of the gravitational temperature, i.e. $T_s = T_g(r = r_s, M = m_s)$, whereas the gravitational temperature should be regarded as a consequence of the equipartition theorem and entropy.

Using equation 3.57 and the gravitational temperature it can be shown that Compton particles, Schwarzschild black holes and extreme Kerr black holes have a mass energy growth that is governed by the second law of thermodynamics which is a generalization of what was already demonstrated in section 3.7. Substituting M/A in equation 3.57 by using the gravitational temperature gives

$$\frac{\mathrm{d}M}{\mathrm{d}A} = \pm \frac{k_b}{4G} \frac{c}{\hbar} T_{gv} = \pm \frac{1}{4} \frac{k_b}{l_l^2 c^2} T_{gv} \tag{3.60}$$

which again leads to the second law of thermodynamics

$$\begin{aligned} \frac{\mathrm{d}Mc^2}{\mathrm{d}A} &= \frac{\mathrm{d}E}{\mathrm{d}A} = \pm \frac{1}{4} \frac{k_b}{l_l^2} T_{gv} \\ \frac{\mathrm{d}Mc^2}{\mathrm{d}S} &= \frac{\mathrm{d}E}{\mathrm{d}S} = \pm T_{gv} \end{aligned} \tag{3.61}$$

when

$$\mathrm{d}S = \frac{1}{4} \frac{k_b}{l_l^2} \, \mathrm{d}A \tag{3.62}$$

The last equation can be derived from the Bekenstein-Hawking entropy for Schwarzschild black holes as stated in equation 3.48. Since equations 3.61 & 3.62 were attained by using equations that are applicable to extreme Kerr black holes, Schwarzschild black holes and Compton particles it makes sense to assume that the Bekenstein-Hawking entropy is also valid for all these cases and it will be referred to as the Compton entropy S_c from now on to reflect the more general meaning.

$$S_c = S_s = k_b \frac{A}{4 l_l^2} = k_b \frac{N}{4} = k_b \frac{\eta_{sq}}{2} \tag{3.63}$$

Please note that the Compton entropy is not applicable to PSUs because A/l_l^2 is only a sensible measure of information when surface area A is much larger than l_l^2 but because the macro and micro state of a PSU are identical its entropy should simply be zero.

Using the gravitational temperature and equation 3.6 the surface temperature of a Compton particle can be defined in terms of its Compton radius and this special case is referred to as the Compton temperature T_c from now on.

$$T_c = T_g(r = r_c) = \frac{2Mc^2}{k_b}\frac{1}{N} = \frac{c\hbar}{2\pi k_b}\frac{l_l^2}{r_c^3} = \frac{E_l}{2\pi k_b}\frac{1}{r_c^3/l_l^3} \tag{3.64}$$

Calculating actual Compton temperatures gives surprisingly low temperatures: the proton has 1.02×10^{-26} Kelvin surface temperature and the electron has 1.65×10^{-36} Kelvin. These temperatures are even far below the cosmic microwave background temperature of 2.73 Kelvin which might explain why experiments never revealed that gravity is connected to thermodynamics.
Using the pressure relationship $P = \delta E/\delta V$, which relates change in volume to change in energy, it is also possible to define the pressure at a Compton particle's surface. This pressure is denoted as Compton pressure and its magnitude is given by

$$P_c = \frac{1}{2}\frac{k_b\,T_c}{r_c\,l_l^2} = \frac{4\pi P_l}{N^2} = \frac{1}{4\pi}\frac{P_l}{r_c^4/l_l^4} = \frac{c\hbar}{4\pi}\frac{1}{r_c^4} \tag{3.65}$$

whereby P_l denotes the Planck pressure $P_l = F_l/l_l^2 = c\hbar/l_l^4$. Using $P = F/A$ a corresponding centripetal force can be defined which is denoted as Compton force:

$$F_c = \frac{P_l\,l_l^2}{r_c^2/l_l^2} = \frac{4\pi F_l}{N} = \frac{F_l}{r_c^2/l_l^2} = \frac{c\hbar}{r_c^2} = ma_c \tag{3.66}$$

As can be seen in the last equation the Compton force F_c is linked to the Compton acceleration a_c (equation 2.49). Moreover it is presumed here that for a seamless force and pressure transition the gravitational force must match F_c at a Compton particle's surface.

Defining the surface temperature of a PSU requires some care because η_{sq}, N and A/l_l^2 are no valid approximations for information on the surface of a PSU since it is too small. This issue can be resolved by defining η_{sq} to be one for a single PSU and using the equipartition theorem (equation 3.38). Then PSU temperature is simply given by

$$T_l = \frac{E_l}{\eta_{sq}k_b} = \frac{m_l c^2}{k_b} = 1.416\,807 \times 10^{32}\ \text{K} \cong \sqrt{2} \times 10^{32}\ \text{K} \tag{3.67}$$

which equals the so called Planck temperature T_l. This result is equal to calculating the gravitational temperature with an area A of $(\sqrt{2}l_l)^2$ instead of $4\pi l_l^2$

$$T_l = \frac{2G}{k_b}\frac{\hbar}{c}\frac{m_l}{(\sqrt{2}l_l)^2} = \frac{2m_l c^2}{k_b}\frac{l_l^2}{(\sqrt{2}l_l)^2} = \frac{m_l c^2}{k_b} = 1.416\,807 \times 10^{32}\ \text{K} \tag{3.68}$$

whereas $2l_l^2$ matches the square area used for the Compton particle surface topology (see figure 7). Please also note that equation 3.67 and the following two equations contain further $\sqrt{2}$ oddities with a deviation of less than 0.2%, 0.1% and 0.9% respectively.

$$k_b\,T_c(r_{cp}) = m_p c^2/\eta_{sq}(r_{cp}) = 1.413\,024 \times 10^{-49}\ \text{J} \cong \sqrt{2} \times 10^{-49}\ \text{J} \tag{3.69}$$

$$k_b\,T_c(r_{ce}) = m_e c^2/\eta_{sq}(r_{ce}) = 2^4 \times 1.413\,024 \times 10^{-60}\ \text{J} \cong 16\sqrt{2} \times 10^{-60}\ \text{J} \tag{3.70}$$

These last two equations denote the theoretical quantity of Compton particle self energy per surface PSU for the proton and electron respectively.

3.10 ENTROPIC GRAVITY - PART TWO

The derivation of Newtonian gravity from thermodynamic considerations as shown in section 3.7 only considered the special case of gravity at a Schwarzschild black hole horizon but the generalizations presented in the previous section also allow a more generalized derivation of Newtonian gravity. The only additional assumption necessary is that the equipartition theorem (equation 3.38), and consequently also the gravitational temperature, are valid at distances greater than an object's radius whereas the energy remains constant, i.e. $E_M = Mc^2$. Subsequently the gravitational temperature T_{gfM} associated with mass M has to fall $\propto 1/r^2$ as area A grows $\propto r^2$ which leads to the range characteristic of Newtonian gravity. Rearranging equation 3.59 to get an expression for gravitational acceleration a_g caused by the presence of mass M makes these relationships more obvious (please note that r is replaced by d in the following equation to highlight that it refers to distance from M instead of M's radius):

$$a_g = \frac{GM}{d^2} = \frac{c^3 l_l^2}{\hbar}\frac{M}{d^2} = \frac{c}{\hbar}\frac{E_M}{d^2/l_l^2} = \frac{4\pi c}{\hbar}\frac{E_M}{A/l_l^2} = \frac{2\pi c}{\hbar}\frac{E_M}{\eta_{sq}} = \frac{2\pi c k_b}{\hbar}T_{gfM} \tag{3.71}$$

The last equation suggests that the presence of a Compton particle somehow affects the entropy & temperature of its surrounding space and that this is causal for gravitational acceleration. Moreover comparing equation 3.71 with equation 2.49 reveals that when using $E_c = E_M$ the relationship of gravitational acceleration to Compton acceleration is given by

$$a_g = \frac{a_c}{d^2/\, l_l^2} \tag{3.72}$$

which means that gravitational acceleration is an extension of the Compton acceleration. This relation also implies that gravity should have a rotational component like Compton particles and section 3.12 will examine this notion in more detail. After that section 3.13 treats the special case $d = r_c$ because a conflict occurs there: at distances close to a Compton particle's radius equation 3.72 & 3.71 are probably no longer valid because the presumed boundary conditions $a_g(r_c) = a_c(r_c)$ and $F_g(r_c) = F_c(r_c)$ are not met.

Equation 3.71 featured a $c/\hbar$ term which is a fundamental energy to acceleration conversion factor with the units m s^{-2}/ J and a similar quantity can be constructed for gravitational force which has the units of N/ K

$$g_{tm} = \frac{2\pi k_b E_m}{c\hbar} = \frac{2\pi c k_b m}{\hbar} \tag{3.73}$$

whereby m is a second mass that is affected by the gravitational attraction of mass M and has an energy of $E_m = mc^2$. For the special case when mass m is a Compton particle equation 3.73 reduces to:

$$g_{tc} = \frac{2\pi k_b}{r_c} = \frac{4\pi^2 k_b}{\lambda_c} \tag{3.74}$$

For the proton this equation evaluates to $4.124\,825 \times 10^{-7}$ N/K and for the electron it yields $2.246\,450 \times 10^{-10}$ N/K. The relationship of entropic gravity to Newtonian gravity can then be stated as follows

$$F_g = G\frac{mM}{d^2} = \frac{G}{c^4}\frac{E_M E_m}{d^2} = \frac{1}{c\hbar}\frac{E_M E_m}{d^2/l_l^2} = g_{tm}\, T_{gfM} = m a_g \tag{3.75}$$

whereby this relationship is valid for Compton particles, Schwarzschild black holes and extreme Kerr black holes because for them the gravitational temperature T_{gf} is a valid quantity.

3.11 BLACKBODY RADIATION

Assuming that a black hole is a perfect black-body radiator its emitted power P_b associated with a surface temperature T and surface area A can be calculated according to

$$P_b = \sigma\, T^4 A \tag{3.76}$$

whereas σ denotes the Stefan-Boltzmann constant $5.670\,367 \times 10^{-8}$ W m^{-2} K^{-4}. Combining the last equation with the gravitational temperature (equation 3.59) gives a quantity which will be referred to as gravitational power P_g.

$$P_g = \sigma T_g^4 A = \sigma \left(\frac{2G}{k_b}\frac{\hbar}{c}\frac{M}{A}\right)^4 A = \sigma \left(\frac{2G}{k_b}\frac{\hbar}{c}\right)^4 \frac{M^4}{A^3} \tag{3.77}$$

The gravitational power can be used to calculate the power emission of a Schwarzschild black hole and for this calculation it is helpful to express its surface area in terms of mass. Using equation 3.9 the sought-after surface area can be expressed in terms of Schwarzschild mass m_s:

$$A_s = 4\pi r_s^2 = \frac{16\pi G^2 m_s^2}{c^4} \tag{3.78}$$

Using A_s to substitute A in equation 3.77 gives the power emitted by a Schwarzschild black hole in terms of its mass:

$$P_{gs} = \sigma \left(\frac{2G}{k_b}\frac{\hbar}{c}\right)^4 \frac{m_s^4 c^{12}}{4^6\pi^3 G^6 m_s^6} = \frac{\sigma c^8 \hbar^4}{4^4\pi^3 G^2 m_s^2 k_b^4} = \frac{\sigma E_l^4 l_l^2}{4^4\pi^3 k_b^4}\frac{m_l^2}{m_s^2} \tag{3.79}$$

The last equation shows that the radiated power is proportional to $1/m_s^2$. Thus if two Schwarzschild black holes of mass M merge to form another Schwarzschild black hole with mass $2M$ the emitted power of the resultant black hole is 1/4th compared to one of the former black holes and only 1/8th compared to the combined emission of the former two black holes. This effectively makes gravity a cooling process and substantiates the notion of a thermodynamic gravity. Repeating the power emission calculation for extreme Kerr black holes by using equation 3.13 and area $A_k = 4\pi r_k^2$ gives:

$$P_{gk} = \sigma \left(\frac{2G}{k_b}\frac{\hbar}{c}\right)^4 \frac{m_k^4 c^{12}}{4^3\pi^3 G^6 m_k^6} = \frac{\sigma c^8 \hbar^4}{4\pi^3 G^2 m_k^2 k_b^4} = \frac{\sigma E_l^4 l_l^2}{4\pi^3 k_b^4}\frac{m_l^2}{m_k^2} = 4^3 P_{gs} \tag{3.80}$$

The last equation shows that extreme Kerr black holes emit much more power than Schwarzschild black holes of identical mass. Assuming that a power emission calculation might also make sense for a Compton particle gives the following result (note: using T_g instead of T_c gives the same result):

$$P_{gc} = \sigma T_c^4 A = \sigma \left(\frac{c\hbar}{2\pi k_b} \frac{l_l^2}{r_c^3} \right)^4 4\pi r_c^2 = \frac{\sigma c^4 \hbar^4 l_l^8}{4\pi^3 k_b^4 r_c^{10}} = \frac{\sigma c^{14} l_l^8 m^{10}}{4\pi^3 k_b^4 \hbar^6} \tag{3.81}$$

According to the last equation a proton radiates 3.458×10^{-142} W which practically equals no radiation. This result fits with the observation that protons are very stable particles which do not evaporate but they still can affect the surrounding space-time and have a collective effect.
PSUs are also expected to be non-radiative since they presumably are the smallest building block of our universe.

3.12 GRAVITATIONAL VORTEX

The absence of the gravitational constant G from fundamental equations for mass (3.7 & 3.15), self energy (2.46), gravitational force (3.27, 3.28, 3.71, 3.75, 3.94) and gravitational potential energy (3.35) suggests that G should be considered as an emergent constant. This makes sense when assuming that the Planck length is a fundamental property of our universe because then all terms in the definition of $G = c^3\, l_l^2/\hbar$ (a variant of equation 3.1) are fundamental constants. But still the question remains what G really means and regarding it as emergent constant also brings conflict with general relativity theory which utilizes G as a fundamental constant in the so called Einstein tensor.

Haramein noted that all planets, suns, fundamental particles and spiral galaxies have spin which led him to the idea that gravity might be the fundamental cause of their spin. This thinking is contrary to general relativity theory where rotating mass is seen as cause for the so called space-time dragging. If Haramein's interesting conjecture is correct gravity should be associated with some kind of vortex and Schwarzschild black holes should transform into extreme Kerr metric black holes over time even without gaining angular momentum from in-falling mass.

The proposition made here is that the gravitational constant G is also linked to Compton particle rotation. Since a two dimensional approach was already useful for spin (section 2.3) and magnetic moment (section 2.4) the same approach is used here for gravity by proposing that a mass M causes a two dimensional vortex that attracts a second mass m. A two dimensional vortex can be approximated as a series of centripetal motion rings of constant velocity when assuming that the velocity differential of the vortex is causing centripetal force on everything in it and that the change of rotational velocity between individual rings is negligible. Using this hypothesis and the centripetal acceleration to tangential velocity relationship $a = v_t^2/d$ the gravitational force F_g caused by such a two dimensional vortex can be expressed as

$$F_g = m a_g = m \frac{v_t^2}{d} = G \frac{mM}{d^2} \tag{3.82}$$

whereby the tangential velocity v_t denotes the velocity of the proposed two dimensional vortex at a certain distance d.

The remaining task is to find a vortex velocity profile by which v_t^2/d mimics the Newtonian gravitational acceleration GM/d^2. To achieve this equation 3.82 has to be rearranged to express the gravitational constant in terms of v_t:

$$G = v_t^2 \frac{d}{M} \tag{3.83}$$

Using the definition for the Planck length as given by equation 3.1 the gravitational constant can also be expressed as follows:

$$G = \frac{l_l^2 c^3}{\hbar} \tag{3.84}$$

Equating the last two expressions for G gives the following equation for the tangential velocity

$$v_t = \sqrt{\frac{l_l^2 c^3}{\hbar} \frac{M}{d}} \tag{3.85}$$

which can be examined in more detail for Compton particles and black holes.

Using the inverse holographic mass equation 3.6 to substitute mass M by the corresponding radius r_{cM} the tangential vortex velocity for the Compton particle case is given by:

$$v_{tc} = \sqrt{\frac{l_l^2\, c^3}{\hbar} \frac{\hbar}{c\, r_{cM}} \frac{1}{d}} = c \frac{l_l}{\sqrt{d\, r_{cM}}} = c \frac{1}{\sqrt{d\, r_{cM}/l_l^2}} \tag{3.86}$$

The last equation can also be expressed in the following way

$$\frac{v_{tc}^2}{c^2} = \frac{l_l^2}{d\,r_{cM}} \tag{3.87}$$

which makes it more obvious that this result is actually sensible: the maximum vortex speed is predicted to be c because the term $d \times r_{cM}$ cannot become less than l_l^2 when assuming that the Planck length is the smallest possible distance in our universe. Furthermore the predicted velocities are very low: one nano meter away from a single proton the vortex velocity should only be around 10^{-14} m/s. The case when d is close to r_{cM} will be examined in the next section.
Inserting v_{tc} back into equation 3.83 gives a new expression for the gravitational constant which reveals why G has a constant value despite its presumed vortex association:

$$G = \frac{l_l^2 c^2}{d\,r_{cM}}\frac{d}{M} = \frac{l_l^2 c^2}{r_{cM} M} = \frac{l_l^2 c^4}{r_{cM} E_M} \tag{3.88}$$

This expression for G is constant because for Compton particles the term $r_{cM} \times M$ equals the constant term $\hbar/c$ which can be recognized by looking at equation 3.7 or 2.47 and consequently equation 3.88 & 3.84 are equal. Using the general centripetal acceleration relationship $a = v_t^2/d$ again the gravitational acceleration corresponding to tangential velocity v_{tc} can be expressed as follows:

$$a_{gc} = \frac{v_{tc}^2}{d} = \frac{c^2}{r_{cM}}\frac{1}{d^2/\,l_l^2} = \frac{a_{cM}}{d^2/\,l_l^2} \tag{3.89}$$

The same calculation can be repeated for extreme Kerr black holes by using equation 3.15 to substitute mass M in the tangential velocity equation 3.85 with the corresponding radius r_{kM}. Doing so gives the following vortex velocity profile for extreme Kerr black holes:

$$v_{tk} = c\sqrt{\frac{r_{kM}}{d}} = c\frac{1}{\sqrt{d\,/r_{kM}}} \tag{3.90}$$

The predicted maximum vortex velocity is again light speed c which will be reached at the black hole horizon. Getting a sensible velocity profile again is actually remarkable as it would also have been possible to get nonsensical velocity results and thus these velocity profiles indicate that G really has an intrinsic association with rotation.
Inserting v_{tk} back into equation 3.83 gives a variant of the extreme Kerr black hole mass as stated in equation 3.13:

$$G = c^2\frac{r_{kM}}{M} = c^4\frac{r_{kM}}{E_M} \tag{3.91}$$

This equation also yields a constant value for G regardless of the black hole's size. Using the general centripetal acceleration relationship $a = v_t^2/d$ again the gravitational acceleration corresponding to tangential velocity v_{tk} can be stated as follows

$$a_{gk} = \frac{v_{tk}^2}{d} = \frac{c^2}{d}\frac{1}{d/r_{kM}} \tag{3.92}$$

whereby the maximum acceleration at $d = r_{kM}$ is given by c^2/r_{kM}.

The distinction between the gravitational acceleration of Compton particles and black holes can be reconciled by substituting the radius in a_{gc} and a_{gk} with the appropriate mass equation. In both cases this substitution leads to the same gravitational acceleration in terms of mass or energy:

$$a_g = \frac{c}{\hbar}\frac{Mc^2}{d^2/l_l^2} = \frac{c}{\hbar}\frac{E_M}{d^2/\,l_l^2} \tag{3.93}$$

The last equation is equal to the gravitational acceleration as stated in equation 3.71 which demonstrates that the gravitational vortex conjecture fits with the thermodynamic gravity approach. Please note that temperature and energy must always be linked to some kind of motion or potential for motion and the two dimensional gravitational vortex seems to fulfil that requirement for thermodynamic gravity though the exact meaning of the gravitational vortex in three dimensional space is not clear yet. Similar situations were already treated in the context of Compton particle spin (section 2.3) & magnetic moment (section 2.4) where the proposed solution involved a certain flow pattern (see figure 3) but it is unclear if the spherical symmetry of gravitational force associated with Compton particles is possible with such a flow pattern and what would happen when several Compton particles are aggregated into a larger mass.

On the other hand it is noteworthy that the gravitational vortex approach has some similarities with general relativity theory. Both models predict co-moving space for rotating bodies and compressing a typical "twisted funnel" depiction of bent space around a rotating black hole into a two dimensional plane gives the depiction of a two dimensional gravity vortex. So at least on a qualitative level there are similarities between these models but the material presented in this document also suggests that the notion of curved space should be discarded in favour of a highly ordered crystalline space structure as presented in section 3.8. A possible reconciliation of this contradiction might be that what appears as twisted and curved three dimensional space is actually an effect of a two dimensional vortex on the holographic surface of our universe.

3.13 STRONG FORCE

Haramein suggested that the strong force might actually be gravitational in nature and has done some exemplary calculations to investigate this assumption (2). As demonstrated hereafter it is possible to substantiate the idea of a gravitation based strong force by using equations which were presented in the gravitational vortex section.

For a Compton particle the gravitational vortex velocity approaches light speed c as distance d decreases (see equation 3.87). On the other hand a Compton particle's equatorial ring speed is also c. These circumstances suggest that at a Compton particle's equatorial ring these velocities should match to have a physically sensible situation. In mathematical terms this expectation can be expressed as $v_{tc}(r_c) = c$ and $a_c = a_g(r_c)$ but setting $d = r_c$ in equation 3.72 & 3.86 shows that these velocity and acceleration equalities are not true. Since for extreme Kerr black holes the equalities $v_{tk}(r_k) = c$ and $a_c = a_g(r_k)$ are true when using $d = r_c = r_k$ the proposed solution is that at distances close to a Compton particle's radius the appropriate gravitational vortex velocity profile is given by v_{tk} (equation 3.90) instead of v_{tc} (equation 3.86). Adapting equation 3.82 accordingly then gives the following force equation for two Compton particles with mass m and M which have radius r_{cm} and r_{cM} respectively:

$$F_s = r_{cm}\frac{Mc^2}{d^2} = \frac{r_{cm}}{r_{cM}}\frac{c\hbar}{d^2} \tag{3.94}$$

Using this force equation for the exemplary case of two protons with mass m_p which are bound together like in an atom, and thus separated by a distance d of $2r_{cp}$, gives:

$$F_{sppa} = r_{cp}\frac{m_p c^2}{(2r_{cp})^2} = \frac{1}{4}\frac{m_p c^2}{r_{cp}} = \frac{c\hbar}{4r_{cp}^2} = 178\,699\ \mathrm{N} \tag{3.95}$$

In contrast using the common Newtonian gravitational force equation gives a much smaller force:

$$F_{gppa} = G\frac{m_p^2}{(2r_{cp})^2} = 1.055\,39 \times 10^{-33}\ \mathrm{N} \tag{3.96}$$

Comparing the strength of these two forces gives:

$$\frac{F_{sppa}}{F_{gppa}} = 1.693\,21 \times 10^{38} \tag{3.97}$$

Remarkably this result matches with the conventional strong force to gravitational force strength ratio which is approximately 10^{38}. This indicates that the nuclear binding force, or strong force, is given by equation 3.94 and gravitational in nature like Haramein suspected. Expressed in more sophisticated language: what is called the strong force seems to be the near field behaviour of gravity. According to Verlinde there is also a gravitational far field behaviour (7) where gravitational force becomes proportional to $1/d$. Moreover the result of equation 3.97 substantiates the gravitational vortex notion and the velocity profile approach.

Using a rearranged version of Newtonian gravitational force (equation 3.82) it is also possible to calculate the equivalent "mid field" mass of the 179 kN force:

$$\sqrt{\frac{178\,699\ \mathrm{N} \times (2r_{cp})^2}{G}} = m_l = \frac{m_\hbar}{\phi_h} \tag{3.98}$$

Surprisingly the result is exactly one Planck mass and in analogy to the unshielded Planck charge, which was treated in section 2.6, the Planck mass might be regarded as the "unshielded" mass. Moreover this result also fits with what was presented in the gravitational potential energy section as it explains why a m_l^2 term appears in equation 3.31.

Because the Compton particle model is applicable to baryons, e.g. protons, and leptons, e.g.

electrons, an issue arises: the gravitation based strong force should also apply to leptons but then electrons would be able to form atoms which is implausible. For example two electrons separated by $2r_{ce}$ should experience an electric repulsion force of 0.000 387 N and a strong force of 0.0530 N which is again equivalent to a "mid field" mass of one Planck mass. What may solve this issue is that at such short distances the involved Compton particles experience an electric repulsion force which is proportional to the unshielded charge. Then the electric repulsion force evaluates to 0.0530 N and counterbalances the strong force. For protons at close distance the situation should be similar and to have a net attractive force within atoms neutrons are presumably required. The question that arises from these considerations though is if Compton particles start to depolarize at such short distances so that their unshielded charge is exposed as assumed in section 2.6 or if the charge shielding mechanism is also related to the gravitational vortex instead of being caused by dipole polarization.

Another interesting result is obtained by calculating v_{tk} for a proton at a distance of $4r_{cp}$ which equals the conventional proton radius. At this distance the predicted vortex velocity is $0.5c$ and this suggests that the proton radius as obtained by experiments could be the result of an averaging effect that is linked to the gravitational vortex. If the PSUs around a Compton particle are actually moving then it likely becomes difficult to measure a Compton particle's boundary. Furthermore the Compton particle model suggests that there is no difference between the "substance" of a Compton particle and the space around it as everything is made from the PSUs in fundamental lattice (see section 3.8).
For a distance of $16r_{cp}$ the vortex velocity is $0.125c$ which shows that the predicted vortex velocity already drops to smaller fractions of c within atomic distances. Moreover it is assumed that as a gravitational source becomes "point like" with increasing distance the vortex velocity profile should blend from v_{tk} into v_{tc} to give the common Newtonian gravity.

3.14 OUR UNIVERSE

Currently it is still disputed if our universe is finite or not and due to cosmological expansion there seems to be no possibility to observe our universe in its full extent even if it were finite. The Cosmological expansion also creates a theoretical boundary inside our universe where objects are moving away from our solar system with light speed c and objects outside of this boundary recede even faster. The associated radius is called the Hubble radius and the corresponding spherical volume is called the Hubble sphere whereby the Hubble radius r_{uh} is calculated by using the Hubble constant $H_0 = 74.3\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$ which is the characteristic value for the current cosmological expansion.

$$r_{uh} = \frac{c}{H_0} = 1.25 \times 10^{26}\,\mathrm{m} \tag{3.99}$$

The corresponding recession velocity v_r is given by Hubble's law

$$v_r = H_0\,d \tag{3.100}$$

whereby d denotes the distance to the observer - earth in our case. According to experiments the energy density of our universe is $9.9 \times 10^{-27}\,\mathrm{kg/m^3}$ as stated by NASA*. This energy density is close to the "critical density" that characterizes a so called flat universe and it is given by:

$$\rho_{uc} = \frac{3H_0^2}{8\pi G} = 1.04 \times 10^{-26}\,\mathrm{kg/m^3} \tag{3.101}$$

Using equation 3.99 & 3.101 the mass which is contained inside the Hubble volume can be estimated as already demonstrated by various researchers

$$m_{uh} = \rho_{uc} \times 4\pi r_{uh}^3/3 = \frac{c^3}{2GH_0} = 8.38 \times 10^{52}\,\mathrm{kg} \tag{3.102}$$

and this mass will be referred to as the Hubble mass from now on. An interesting congruence is now obtained when calculating the energy density of a Schwarzschild black hole whose size matches that of the Hubble sphere:

$$\rho_{us} = \frac{m_s(r_{uh})}{4\pi r_{uh}^3/3} = \frac{8.38 \times 10^{52}\,\mathrm{kg}}{8.08 \times 10^{78}\,\mathrm{m^3}} = 1.04 \times 10^{-26}\,\mathrm{kg/m^3} = \rho_{uc} \tag{3.103}$$

This result shows that the Hubble sphere qualifies as Schwarzschild black hole because their energy density is identical and setting $r_s = r_{uh}$ in equation 3.9 also proves that equality analytically. This is a peculiar result since it suggests that we might live inside a black hole and that despite this circumstance space is flat because the critical energy density is met. This is in line with the PSU topology of section 3.8 which also suggests that the structure of space is not curved but perfectly

* http://map.gsfc.nasa.gov/universe/uni_matter.html

euclidean instead.

Another characteristic energy of our universe is the so called vacuum energy, or zero point energy, whose density is very different from the critical density and this discrepancy is also known as the ”vacuum catastrophe”. Assuming that the vacuum has a PSU structure which is identical to the one presented in section 3.8 allows to calculate the mass density of the vacuum as follows:

$$\rho_v = \frac{R_{oct}(r) \times m_l}{4\pi r^3/3} = \frac{1}{2}\frac{m_l}{l_l^3} = 2.577\,59 \times 10^{96}\ \mathrm{kg/m^3} \tag{3.104}$$

Expressing this result as an energy density instead of a mass density yields:

$$u_v = \rho_v\, c^2 = \frac{1}{2}\frac{m_l c^2}{l_l^3} = 2.316\,62 \times 10^{113}\ \mathrm{J/m^3} \tag{3.105}$$

This energy density is in line with quantum physical calculations which estimated the vacuum energy density to 10^{113} J/m^3 and thus the PSU topology provides an answer to the question why we do not experience this enormous energy: the vacuum energy density is constant throughout our universe and this energy is also bound in countless rotating PSUs.

If our local Hubble sphere qualifies as Schwarzschild black hole might our whole universe then actually be an extreme Kerr black hole? Depending on how large our universe is and where our Hubble volume is situated in it we might not notice our universe’s rotation since the radial velocity at our location might be very low. In this line of thinking dark energy is linked to the rotational energy of our universe which would resolve the so called vacuum catastrophe since dark energy and vacuum energy would then relate to two different physical properties: vacuum energy is the energy contained in space itself and dark energy is linked to our universe’s rotation which presumably drags all galaxies along. Moreover the expansion of our universe could then by explained by the angular momentum of our universe: as our universe’s rotation slows down it expands to conserve angular momentum. The fact that the Hubble constant can also be expressed in terms of frequency ($H_0 = 2.41 \times 10^{-18}$ Hz) is a first hint towards the rotating universe conjecture and it is indeed possible to find an expression for our universe’s angular acceleration α_u which utilizes Hubble’s constant. First Hubble’s law (equation 3.100) must be reformulated as follows to give an expression for distance d:

$$d = \frac{v_r(d)}{H_0} = \frac{\delta d(d)}{\delta t}\frac{1}{H_0} \tag{3.106}$$

Here $\delta d(d)$ denotes the isotropic expansion of space in a unit of length at a distance d during a small time interval δt. Since Hubble’s law applies in all directions any coordinate origin can be chosen but for the following calculation d is defined as the distance from our universe’s rotation axis in a plane perpendicular to it. Then distance d can be used in the angular acceleration equation for circular motion to define our universe’s angular acceleration:

$$\alpha_u = \frac{\delta\omega}{\delta t} = \frac{a_t(d)}{d} = \frac{a_t(d)}{v_r(d)}H_0 = \frac{a_t(d)\,\delta t}{\delta d(d)}\,H_0 = \frac{v_t(d)}{\delta d(d)}\,H_0 \tag{3.107}$$

Here $\delta\omega$ denotes the change in our universe’s angular velocity during time interval δt, $a_t(d)$ denotes the tangential acceleration at distance d and $v_t(d)$ denotes the tangential velocity at distance d in a plane perpendicular to the universe’s rotation axis. If it were possible to measure $a_t(d)$ or $v_t(d)$ for a known distance d then our universe’s angular acceleration α_u could be determined.
But what does it mean if Hubble’s law is a consequence of an expanding extreme Kerr black hole universe? This scenario implies that our universe is embedded in another universe and in this other universe our universe should appear as an extreme Kerr black hole according to the physics of the enclosing universe which in turn suggests a possibly infinite fractal multiverse structure of universes within universes. In this conception the boundary of an universe is defined by its Kerr black hole horizon and this horizon’s purpose should be comparable to a cellular membrane in biology, i.e. separating individual entities and regulating the interaction. This conjecture implicitly also contains the requirement that gravity must exist in all universes.

Interestingly there might be a way to find out how fast our solar system is moving relative to the fundamental PSU structure of our universe. Scrutinizing the electron radius uncovers an oddity - it has a curious relationship to the radius of our universe

$$\frac{1}{2}\frac{r_{uh}}{r_{ce}} = 1.61 \times 10^{38} \cong \varphi \times 10^{38} \tag{3.108}$$

whereby φ denotes the golden ratio 1.61803398875... . Of course three matching leading digits are no proof that the golden ratio is really of relevance here but should the golden ratio appear in physics this would be a strong indication for a fractal universe since in geometry φ characterizes a self similar division pattern. Moreover the golden ratio and the Planck length are numerically close when disregarding the Planck length's exponents which sparks a speculative thought: is it possible that the correct Planck length is given by $\varphi \times 10^{-35}$ m ? Dividing these values gives the following ratio:

$$\frac{\varphi \times 10^{-35}\,\mathrm{m}}{l_l} = 1.001117 \tag{3.109}$$

In case our solar system is indeed moving relative to an underlying vacuum structure then length contraction should become relevant and interpreting the result of equation 3.109 as a Lorentz factor gives the corresponding velocity:

$$c\sqrt{1-\frac{1}{\gamma^2}} = c\sqrt{1-\frac{1}{1.001117^2}} = 1.415\,790 \times 10^7\ \mathrm{m/s} \cong \sqrt{2} \times 10^7\ \mathrm{m/s} \tag{3.110}$$

The calculated relative velocity is approximately 4.72% of light speed which is not an unreasonably high result. The appearance of another $\sqrt{2}$ oddity is also a puzzling outcome that defies chance.

One of the other remaining big cosmological mysteries, namely dark matter, might have already been solved by Mills. According to Mills dark matter can be explained by interstellar clouds of hydrinos: hydrogen atoms with their electron below the proclaimed ground state, i.e. with a fractional quantum number n. This property makes hydrinos unreactive and also gives them distinct spectral absorption lines (4). These properties might explain why hydrinos remained undetected.

3.15 COUPLING CONSTANTS

Force coupling constants denote the relative strength of the different fundamental forces and are commonly denoted by the greek letter α. Usually coupling constant calculations are done by dividing the potential energy associated with a force between two particles by the energy of a hypothetical photon with wavelength $\lambda = c/f = 2\pi \times d$ whereby d denotes the separation between these particles.

As already shown in section 2.6 the electromagnetic coupling constant, which is also called fine-structure constant or Sommerfeld constant, arises naturally from a polarization effect inside Compton particles (see equation 2.40) and is given by:

$$\alpha = \frac{e^2}{4\pi\epsilon_0\, d} \Big/ \frac{ch}{2\pi d} = \frac{e^2}{q_l^2} = 0.00729735 = \frac{1}{137.036} \tag{3.111}$$

For a further discussion on Compton particle polarization see also section 3.13.

The gravitational coupling constant is usually calculated using the proton as reference particle:

$$\alpha_g = \frac{Gm_p^2}{d} \Big/ \frac{ch}{2\pi d} = \frac{Gm_p^2}{c\hbar} = 5.905\,956 \times 10^{-39} = \frac{1}{1.693\,206 \times 10^{38}} \tag{3.112}$$

Please note that the last equation's result equals the inverse result of equation 3.97 which is in line with the fact that the strong force coupling factor α_s is usually cited in the literature as $\cong 1$ for atomic distances and thus equation 3.97 equals α_s/α_g. Due to the various relationships in the Compton particle model there are also various other ways to calculate the gravitational coupling constant and as shown by Haramein in (2) the gravitational coupling constant can also be retrieved from mass ratios or even from purely geometric considerations

$$\alpha_g = \frac{m_p^2}{m_l^2} = \phi_h(r_{cp})^2 \tag{3.113}$$

whereby the $\alpha_g = \phi_h(r_{cp})^2$ relationship is a consequence of $\phi_h(l_l) = 1$ and equation 3.6. Other ways of expressing the gravitational coupling constant are

$$\alpha_g = \frac{\omega_{cp}^2}{\omega_l^2} = \frac{l_l^2}{r_{cp}^2} = \frac{m_l^2}{m_k(r_{cp})^2} = \frac{m_p}{m_k(r_{cp})} \tag{3.114}$$

whereby $m_k(r_{cp})$ denotes a proton's (hypothetical) black hole mass.

Besides the force coupling constants there seem to be other characteristic coupling factors which are related to fundamental geometry: the factor $\sqrt{2} = 1.414214...$ has already been encountered in numerous equations but there are also approximate $\sqrt{2\sqrt{2}} = 1.681793...$, $1+\sqrt{2} = 2.414214...$

and $2\sqrt{2} = 2.828427...$ appearances in other fundamental relationships. The relevant equations were 2.48, 2.56, 3.19, 3.52, 3.53, 3.67, 3.69, 3.70, 3.110, 3.112 and more occurrences are listed hereafter:

$$\text{Proton mass: } m_p = 1.672\,622 \times 10^{-27}\,\text{kg} \quad \text{(deviation less than 0.6\%)} \tag{3.115}$$

$$\text{Electron Compton wl.: } \lambda_{ce} = 2\pi r_{ce} = 2.426\,31 \times 10^{-12}\,\text{m} \quad \text{(deviation close to 0.5\%)} \tag{3.116}$$

$$\text{Hubble constant: } H_0 = 2.41 \times 10^{-18}\,\text{Hz} \quad \text{(deviation not ascertainable)} \tag{3.117}$$

$$r_{ce}/\,l_l = 2.389\,261 \times 10^{22} \quad \text{(deviation less than 1.1\%)} \tag{3.118}$$

$$\alpha r_{ce} = 2.817\,94 \times 10^{-15}\,\text{m} \quad \text{(deviation less than 0.4\%)} \tag{3.119}$$

$$r_{cp}/\,\alpha = 2.881\,99 \times 10^{-14}\,\text{m} \quad \text{(deviation less than 1.9\%)} \tag{3.120}$$

$$\text{Proton ang. fr.: } \omega_{cp} = \frac{c}{r_{cp}} = \frac{2\pi c}{\lambda_{cp}} = 1.425\,486 \times 10^{24}\,\text{Hz} \quad \text{(deviation less than 0.8\%)} \tag{3.121}$$

Writing down the relationship between c and $\hbar$ also results in a noteworthy $\sqrt{2}$ occurrence:

$$c = \frac{a_l}{\omega_l} \cong 2\hbar\sqrt{2} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J} \tag{3.122}$$

Since $\hbar = E_l\,t_l$ the scaling factor $2\sqrt{2} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J}$ also appears in the Planck acceleration to Planck energy relationship

$$a_l = \frac{c^2}{l_l} = \frac{c}{t_l} \cong 2E_l\sqrt{2} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J} \tag{3.123}$$

whereby $t_l = l_l/c = 1/w_l$ denotes the Planck time. Please note that the factor 10^{42} already puzzled physicists of the early 20th century in what is known as Dirac's large number hypothesis. Moreover the energy relationship of equation 3.123 extends to the domain of temperature and it is also linked to the $\sqrt{2}$ appearance in equation 3.67.

$$E_l \cong \frac{a_l}{2\sqrt{2} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\text{J}} \cong k_b\sqrt{2} \times 10^{32}\,\text{K} \tag{3.124}$$

The key to understanding all these numerological mysteries presumably lies in the fractal PSU topology as presented in section 3.8 and rearranging as well as expanding equation 3.122 reveals an underlying connection:

$$\begin{aligned} \frac{c}{h} &\cong \frac{2\sqrt{2}}{2\pi} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J} \\ &\cong \frac{\sqrt{2}l_l}{\pi l_l} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J} \\ &\cong \frac{\text{octahedron side length}}{\text{half PSU circumference}} \times 10^{42}\,\text{m}\,\text{s}^{-2}/\,\text{J} \end{aligned} \tag{3.125}$$

The last equation, which has a deviation of less than 0.51%, shows that the linear motion constant c and the rotational motion constant h are related by the geometric properties of the PSU topology which presumably is the cause of the various $\sqrt{2}$ appearances. Should this conjecture be correct the relationships which exhibit approximate $\sqrt{2}$ terms are assumed to become exact in case the relevant fundamental constants were determined to perfect precision and compensated for possible relativistic effects.

As Burkard Polster, who is known as the Mathologer on YouTube, explains an equilateral fractal triangle of side length $4a$ consists of 16 equilaterial sub-triangles of sidelength a. This fractal relationship can also be visualized using the PSU topology which was presented in section 3.8:

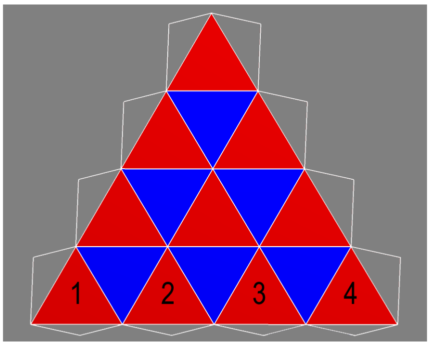

Figure 19: Fractal triangle

Generalizing this relationship and adopting it for the PSU topology a triangle side length of $k\sqrt{2}l_l$ corresponds to the following total sub-triangle count n_{tri}:

$$n_{tri} = \left(\frac{k\sqrt{2}l_l}{\sqrt{2}l_l}\right)^2 = k^2 \tag{3.126}$$

Consequently the number of sub-triangles k which are adjacent to a triangle edge equals $\sqrt{n_{tri}}$. For the simple case of $n_{tri} = 4$, which corresponds to three red triangles (each one an octahedron face) and one enclosed blue triangle (one tetrahedron face) in figure 19, the number of sub-triangles on a triangle edge is $k = \sqrt{4} = 2$. This demonstrates that the square root is a general scaling feature of the fractal PSU topology.

In case the fractal universe idea is true there should also be some reason why proton and electron mass as well as radius have the measured values. In a fractal universe these properties should be in some kind of resonance or special geometric relationship with other fundamental physical quantities. It was already shown in this section that some proton and electron properties exhibit a $\sqrt{2}$ anomaly but there are more noteworthy relationships. Using a slightly modified variant of equation 3.57 gives the following differential relationship for the proton:

$$\frac{\mathrm{d}\, m_\hbar(r_{cp})}{\mathrm{d}r^2} = -\frac{1}{2}\frac{m_\hbar(r_{cp})}{r_{cp}^2} = -\frac{1}{2}\frac{\hbar}{c\, r_{cp}^3} = -18\,908.3\,\mathrm{kg/m^2} \cong -\frac{1}{\alpha^2}\,\mathrm{kg/m^2} \tag{3.127}$$

The appearance of the Sommerfeld constant α in this context is extraordinary and what the last equation means is that the rate of change for proton mass with radius squared is approximately $-\alpha^{-2}$ kg/m^2 at a proton's surface whereby the deviation from the exact result is less than 0.7%. Another noteworthy differential relationship can be found for the electron:

$$\frac{\mathrm{d}\, m_\hbar(r_{ce})}{\mathrm{d}A} = -\frac{1}{2}\frac{m_\hbar(r_{ce})}{A(r_{ce})} = -\frac{1}{8\pi}\frac{\hbar}{c\, r_{ce}^3} = -2.430\,615\times 10^{-7}\,\mathrm{kg/m^2} \cong -(1+\sqrt{2})\times 10^{-7}\,\mathrm{kg/m^2} \tag{3.128}$$

The deviation of the approximation is less than 0.7% and please note that the Hubble constant also features an approximate $1+\sqrt{2}$ term as shown in equation 3.117. The last equation constitutes the second piece of evidence besides equation 3.108 which suggests that there is a special connection between the Hubble constant/radius and the electron radius. Additionally there is also a remarkable numerical relationship between the proton and the Hubble sphere

$$2\frac{m_s(r_{uh})}{m_p} = \frac{m_k(r_{uh})}{m_p} = 1.00\times 10^{80} \tag{3.129}$$

whereby the same result can be obtained when using the involved radii directly:

$$\frac{r_{cp}}{l_l}\frac{r_{uh}}{l_l} = \frac{r_{cp}}{l_l^2}\frac{c}{H_0} = \frac{r_{cp}}{l_l}\frac{1}{H_0\, t_l} = 1.00\times 10^{80} \tag{3.130}$$

Can this neat result just be pure coincidence? Because the Hubble constant is assumed to change with time the last equation might also imply that some fundamental physical quantities are changing too in case the proportionality constant 10^{80} remains unchanged during the lifetime of our universe.

Dividing volume and area properties of the proton and electron also reveals that their relative properties are not purely coincidental which makes sense for a fractal universe.

$$\frac{m_e}{A(r_{ce})}\bigg/\frac{m_p}{A(r_{cp})} = \frac{V(r_{cp})}{V(r_{ce})} = \frac{r_{cp}^3}{r_{ce}^3} = 1.615\,376\times 10^{-10} \cong l_l\times 10^{25}/\,\mathrm{m} \cong \varphi\times 10^{-10} \tag{3.131}$$

The deviation is less than 0.06% for the approximation using the Planck length l_l and less than 0.2% for the approximation using the golden ratio φ. The significance of the the golden ratio was already discussed in the context of equation 3.108 and the same thoughts apply here.

3.16 UNCERTAINTY

A side effect of the vacuum topology as presented in section 3.8 is an inherent uncertainty in position since space is granular and therefore not infinitely divisible. This implies that even straight motions are jittery unless they are exactly along an octahedron edge or along the direction of an inner diagonal. In any case the shortest measurable distance along an arbitrary coordinate axis cannot be smaller than a Planck length and denoting the uncertainty in position by δx then gives the following definition:

$$\delta x \geqq l_l \tag{3.132}$$

There is also another source of uncertainty that arises from PSU configuration changes which presumably happen in quantum intervals every $t_l = l_l/c = 5.391\,160 \times 10^{-44}$ seconds whereby t_l denotes the Planck time. Please note that in a complete theory of quantum physics everything has to be quantized - even time. Consequently our universe must be "frozen" between individual Planck time intervals but since physics usually treats time as continuous the Planck time freeze introduces a temporary deviation from mathematical calculations. This effect must also be regarded as a quantum physical uncertainty and thus the uncertainty in time, which is denoted here as δt, is given by:

$$\delta t \geqq t_l \tag{3.133}$$

An ideal PSU configuration change has the following properties: a PSU "jumps" a distance l_l during a Planck time interval t_l. Consequently such a jump happens with a speed of $l_l/t_l = c$ which corresponds to a kinetic jump energy of $\delta E = m_l c^2/2$ as well as a jump momentum of $\delta p = m_l c$ and multiplying these quantities with other quantum limits should result in further granularity induced limits. The quantum physical uncertainty relation of position and momentum therefore evaluates to

$$\delta x\, \delta p \geqq l_l\, m_l\, c = l_l \frac{\hbar}{l_l c} c = \hbar \tag{3.134}$$

when using equation 2.11 to substitute m_l. This result seems to be sensible although it is not in full agreement with contemporary quantum physics which states an uncertainty value of $\hbar/2$ instead.

Calculating the uncertainty relation for energy and time using the same approach gives:

$$\delta E\, \delta t \geqq \frac{1}{2} m_l\, c^2\, t_l = \frac{1}{2} \frac{\hbar}{l_l c} c^2 \frac{l_l}{c} = \frac{\hbar}{2} \tag{3.135}$$

This result is in agreement with contemporary quantum physics and thus a PSU configuration change in the vacuum topology actually defines the limit for the quantum physical uncertainty relation of energy and time.

4 QUANTUM ELECTROMAGNETISM

In the previous sections a new perspective on fundamental particles and gravity was presented which subsequently requires that electromagnetism is reconsidered too. Thus Maxwell's equations for electromagnetism, which are a macroscopic abstraction, also need a quantum physical description that fits naturally with the previously presented models and concepts. Especially the PSU should play a prominent role in such a description of electromagnetism since it is also the fundamental charge element in our universe and the first steps towards a PSU based description of electromagnetism are presented in the following sections.

4.1 FORCE UNIFICATION

Before treating the basic equations of electromagnetism it is demonstrated here that electromagnetic force and gravitational force can be united naturally when examining them at the PSU level. The gravitational force between two PSUs at a distance d is given by:

$$G m_l^2 \frac{1}{d^2} \tag{4.1}$$

Please note that a single PSU should not create frame dragging/vortex effects in its vicinity like a Compton particle. The magnitude of the electrostatic force between two PSUs is:

$$\frac{|q_l|^2}{4\pi\epsilon_0} \frac{1}{d^2} \tag{4.2}$$

The last two force equations are actually equal in strength and multiplying them by d^2 results in the same constant expression:

$$G m_l^2 = \frac{|q_l|^2}{4\pi\epsilon_0} = c\hbar = 3.161\,527 \times 10^{-26}\ \mathrm{N\,m^2} \approxeq \pi \times 10^{-26}\ \mathrm{N\,m^2} \tag{4.3}$$

This force equality is characterized by the $c\hbar$ term which will be referred to as the fundamental force gauge from now on. Please note that the $c\hbar$ term also appears in the Schrödinger equation (2.58) and all fundamental force equations (3.28, 3.94, 4.10, 4.20) after reformulating them as well as the

Compton energy (equation 2.46). The presence of c and h in all these equations makes sense because they are the fundamental constants for linear and rotational motion.
Physicists have long wondered why gravity is weak but equation 4.3 demonstrates that it isn't at the PSU level and moreover section 3.13 shows that gravity is getting stronger over short distances. Interestingly equation 4.3 also contains an approximate π relationship with a deviation of less than 0.64%. As section 3.15 has explained the appearance of π and $\sqrt{2}$ in fundamental equations is actually sensible and presumably related to the PSU structure as presented in section 3.8.

As shown by the following equation the fundamental forge gauge term $c\hbar$ is also present in the definition of the Planck force

$$F_l = c\hbar/l_l^2 = m_l c^2/\, l_l = m_l a_l = c^4/G \tag{4.4}$$

besides a l_l^2 term which is presumably linked to entropy and information (see also equation 3.30, 3.37, 4.12 and 4.18). Please note that the Planck force might be regarded as a reference force but it is neither the smallest nor largest possible force in our universe. The Planck acceleration though should be the maximum possible translational acceleration because it denotes a PSU's acceleration from rest to light speed c over a distance of one Planck length l_l during one fundamental Planck time tick t_l as demonstrated by the following equation:

$$a_l = \frac{c - 0\,\mathrm{m/s}}{t_l} = \frac{c^2}{l_l} = 5.560\,816 \times 10^{51}\,\mathrm{m/s^2} \tag{4.5}$$

A faster configuration change is presumably not possible and the Planck acceleration also defines the largest possible centripetal acceleration as given by c^2/l_l.

Translational acceleration slower than the Planck acceleration can be stated as

$$\frac{j}{n} a_l = \frac{j}{n}\frac{c^2}{l_l} \quad \text{(with } j \leqq n\text{)} \tag{4.6}$$

whereby j denotes the number of quantum position jumps in the last n Planck time ticks. Please note that the last equation implies that every acceleration should be proportional to c^2 and in fact gravitational, electrostatic and magnetic acceleration can all be rearranged to exhibit a c^2 term (see equation 3.27, 4.11 & 4.25). The c^2 term also propagates to force and energy equations as can be shown by calculating the energy for moving a particle with constant force F over a distance $d = j \times l_l$:

$$E_{work} = F \times d = m\frac{j}{n}\frac{c^2}{l_l} \times j\, l_l = \frac{j^2}{n}\, mc^2 \tag{4.7}$$

In case energy, position and time could be measured accurately enough the c^2 proportionality of force and energy for translational motion should be revealed.

The same argument can probably made for centripetal acceleration and in accordance with this presumption the Compton acceleration a_c also exhibits a c^2 term like the Planck acceleration which incidentally also explains the appearance of c^2 in the famous relationship $E = mc^2$: rearranging equation 2.49 and using equation 3.7 gives $E_c = a_c/(c/\hbar) = (c^2/r_c)/(c/\hbar) = mc^2$.

4.2 COULOMB'S LAW

Coulomb's electrostatic force law is usually expressed as

$$F_e = ma_e = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{d^2} \tag{4.8}$$

but to be more consistent with the PSU concept Coulomb's law should be expressed in a form that is more sensible in the PSU context. This can be achieved by reformulating the vacuum permittivity ϵ_0 using equation 2.40 to express it in terms of other fundamental constants

$$\epsilon_0 = \frac{1}{4\pi}\frac{q_l^2}{c\hbar} = \frac{1}{4\pi}\frac{e^2}{c\hbar\alpha} \tag{4.9}$$

which in turn allows writing Coulomb's law in the following form:

$$F_e = ma_e = \frac{c\hbar}{d^2}\frac{q_1 q_2}{q_l^2} = \frac{c\hbar}{d^2}\frac{\alpha q_1 q_2}{e^2} \tag{4.10}$$

Physics literature usually doesn't express F_{el} in this way but this expression is more sensible in the PSU context and physically more revealing. In particular because equation 4.10 contains fundamental

charge terms and the $c\hbar$ term which is the fundamental force gauge of equation 4.3. Moreover equation 4.10 has similarity with the gravitational force equation 3.28 whereby this similarity only becomes apparent when using Planck units instead of G and ϵ_0 for the respective force equation.
For the special case of two Compton particles with fundamental charge e which cause electric force on each other mass m can be substituted by radius r_{cm} using equation 3.7 and subsequent rearranging of equation 4.10 then gives the following Compton particle specific electrostatic acceleration:

$$a_{ecc} = \frac{r_{cm} c^2 \alpha}{d^2} = \frac{\lambda_c c^2 \alpha}{2\pi d^2} = \alpha r_{cm} \omega_d^2 \tag{4.11}$$

Here the c^2 proportionality factor for fundamental acceleration appears again which was already discussed in section 4.1.

Writing the electrostatic force in terms of the Planck force F_l is also interesting since then all fractions reduce to dimensionless scaling factors:

$$F_e = F_l \frac{1}{d^2/l_l^2} \frac{q_1 q_2}{q_l^2} \tag{4.12}$$

In this variant electrostatic force has similarity with gravitational force as expressed in equation 3.30.

4.3 POTENTIAL ENERGY

Equation 2.41 already showed that electrostatic potential energy can be expressed as hf term and this understanding is generalized here whereby the used calculation approach is similar to the gravitational potential energy case (see section 3.6).

Substituting ϵ_0 in equation 2.36 by using equation 2.40 and furthermore substituting distance d with the angular frequency $\omega_d = c/d = 2\pi f_d$ (equation 3.34) allows expressing electrostatic potential energy in terms of frequency and charge:

$$U_e = -\hbar\omega_d \frac{\alpha q_1 q_2}{e^2} = -hf_d \frac{\alpha q_1 q_2}{e^2} = -hf_d \frac{q_1 q_2}{q_l^2} \tag{4.13}$$

For two Compton particles with charge e the last equation reduces to the astoundingly simple expression:

$$U_{ecc} = -\hbar\omega_d \frac{e^2}{q_l^2} = -\alpha\hbar\omega_d = -\alpha h f_d \tag{4.14}$$

It is remarkable that hf terms are applicable to photon energy, Compton particle energy, gravitational potential energy and electrostatic potential energy. This correlation highlights that the hf term has a universal meaning in our universe and that understanding physics in terms of frequency is important.

4.4 BIOT SAVART LAW

Before examining magnetic force in the PSU context the Biot Savart law for magnetic fields has to be treated which is usually stated as

$$d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I\, d\mathbf{s} \times \hat{\mathbf{r}}}{d^2} \tag{4.15}$$

whereby μ_0 denotes the magnetic constant, $d\mathbf{s}$ is a short segment carrying current I and $d\mathbf{B}$ is the magnetic field caused by the electric current in $d\mathbf{s}$. Furthermore for a given point in space d denotes the distance to the position of the current segment and $\hat{\mathbf{r}}$ is the normalized displacement vector of that point to the segment's position.

Using the relationship $c^2 = 1/(\epsilon_0\mu_0)$ and equation 4.9 it is possible to express μ_0 in terms of other fundamental constants:

$$\mu_0 = \frac{1}{\epsilon_0 c^2} = 4\pi \frac{c\hbar}{q_l^2 c^2} = 4\pi \frac{c\hbar\alpha}{e^2 c^2} \tag{4.16}$$

The last equation then allows writing the Biot Savart law without μ_0:

$$d\mathbf{B} = \frac{c\hbar}{d^2} \frac{I\, d\mathbf{s} \times \hat{\mathbf{r}}}{q_l^2 c^2} = \frac{c\hbar}{d^2} \frac{\alpha I\, d\mathbf{s} \times \hat{\mathbf{r}}}{e^2 c^2} \tag{4.17}$$

The $c\hbar$ term appears again here which is the fundamental force gauge as explained in section 4.1.

Moreover equation 4.17 can also be expressed in terms of the Planck force:

$$d\mathbf{B} = F_l \frac{1}{d^2/l_l^2} \frac{I\, d\mathbf{s} \times \hat{\mathbf{r}}}{q_l^2 c^2} = F_l \frac{1}{d^2/l_l^2} \frac{\alpha I\, d\mathbf{s} \times \hat{\mathbf{r}}}{e^2 c^2} \tag{4.18}$$

4.5 LORENTZ FORCE LAW

The magnetic part of the Lorentz force law is given by

$$\mathbf{F}_m = m\,\mathbf{a}_m = q\,\mathbf{v} \times \mathbf{B} \tag{4.19}$$

for a particle with charge q and mass m moving with velocity **v** through a magnetic field **B**. Combining the magnetic part of the Lorentz force law with the Biot Savart law gives an expression for (differential) magnetic force which is more aligned with the force equations 3.28 and 4.10 than the commonly used expressions.

$$\mathrm{d}\mathbf{F}_m = m\,\mathrm{d}\mathbf{a}_m = \frac{c\hbar}{d^2}\frac{Iq\,\mathbf{v} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}})}{q_l^2 c^2} = \frac{c\hbar}{d^2}\frac{\alpha Iq\,\mathbf{v} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}})}{e^2 c^2} \tag{4.20}$$

Please note that the fraction involving current I is a pure scaling term without dimensions.

In terms of the Planck force the magnetic force can be expressed as follows:

$$\mathrm{d}\mathbf{F}_m = F_l \frac{1}{d^2/\,l_l^2}\frac{Iq\,\mathbf{v} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}})}{q_l^2 c^2} = F_l \frac{1}{d^2/\,l_l^2}\frac{\alpha Iq\,\mathbf{v} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}})}{e^2 c^2} \tag{4.21}$$

Like in the Coulomb's force law case the caused Compton particle acceleration can be examined. Applying equation 4.20 to a Compton particle with charge $q = e$, using $I = \delta q/\delta t = ne/\delta t$, substituting mass m by radius r_{cm} using equation 3.7 and rearranging for $\mathbf{a}_m$ gives:

$$\mathrm{d}\mathbf{a}_{mc} = \frac{r_{cm} n\alpha}{d^2\,\delta t}\mathbf{v} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}}) \tag{4.22}$$

Assuming that the current is generated by a single Compton particle ($n = 1$) that travels with light speed through a Planck length current segment ($\delta t = l_l/c$, $\mathrm{d}\mathbf{s} = l_l\hat{\mathbf{s}}$) and assuming furthermore that the accelerated Compton particle hypothetically already moves with light speed ($\mathbf{v} = c\hat{\mathbf{v}}$) the last equation results in an upper limit for the magnetic acceleration of Compton particles:

$$\mathrm{d}\mathbf{a}_{mc\_max} = \frac{r_{cm} c^2 \alpha}{d^2}\frac{\hat{\mathbf{v}} \times (\mathrm{d}\mathbf{s} \times \hat{\mathbf{r}})}{l_l} \tag{4.23}$$

$$\mathbf{a}_{mc\_max} = \frac{r_{cm} c^2 \alpha}{d^2}\hat{\mathbf{v}} \times (\hat{\mathbf{s}} \times \hat{\mathbf{r}}) \tag{4.24}$$

Since the involved vectors are all normalized the corresponding magnitude is given by:

$$a_{mc\_max} = \frac{r_{cm} c^2 \alpha}{d^2} = \frac{\lambda_c c^2 \alpha}{2\pi d^2} = \alpha r_{cm}\omega_d^2 = a_{ecc} \tag{4.25}$$

This result demonstrates that equation 4.11 & 4.25 are equal and it is noteworthy that this equality followed from adapting equations for electric and magnetic force to the Planck units and applying the Compton particle model. This equality is also a necessary property of electric and magnetic force in order to not violate relativistic force invariance in different inertial frames as required by special relativity theory. Moreover the c^2 acceleration factor appears again in the last equation which is expected for acceleration caused by fundamental forces as explained in section 4.1.

4.6 ELECTRIC & MAGNETIC FIELD

After expressing some of the fundamental electromagnetism equations in a way that is more suited for the dipole / PSU view of quantum physics the question remains how electromagnetic fields are structured in space-time. Thieme provided some suggestions on this question in his book (1) and this section is elaborating on these suggestions.

In the PSU context macroscopic electrostatic fields might be explained by grouping PSUs into dipoles and assuming that Compton particles polarize the space around them as shown schematically in the following picture.

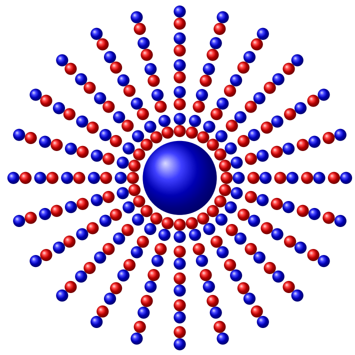

Figure 20: Dipole polarization in space

With increasing distance from the polarization source the number of aligned dipoles in a particular volume decreases. In three dimensional space regions of near identical polarization density can be conceived as spherical shells which matches the electrostatic field symmetry expected from a single charged Compton particle that is stationary. When two charged Compton particles come close enough to each other their dipole patterns start to interact and the resultant net effect should match with the superposition of their macroscopic electric fields. Furthermore the changing dipole pattern is expected to cause a back reaction on the two charged Compton particles and this effect presumably constitutes the macroscopic electrostatic force.

In comparison a magnetic field is generated by moving charges that cause an oscillatory movement in the individual dipoles. The following diagrams illustrate two consecutive moments of dipole oscillation which is caused by an imagined current carrying wire that is composed of three moving electrons.

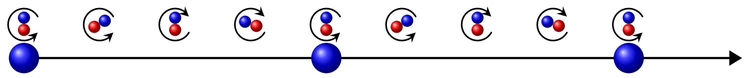

Figure 21: Dipole oscillation

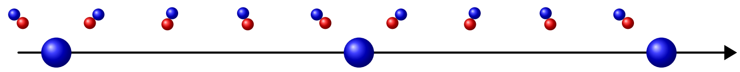

Figure 22: Dipole oscillation at a later time

The dipole oscillation frequency depends on the speed of the moving electrons and the spacing between individual electrons whereas the oscillation amplitude depends on distance to the imagined current wire. In three dimensional space dipoles with identical phase can be conceived as rings around the current carrying wire. Furthermore rings of consecutive phase will form notional tubes which have the cylindrical symmetry expected from a magnetic field around a current carrying wire. In case the current stops the dipole oscillation will also cease and the corresponding macroscopic magnetic field will vanish as expected from a magnetic field. When a charged Compton particle moves into a region of oscillating dipoles they will cause attractive and repulsive effects on the incoming Compton particle but these effects will not cancel out on average which causes a trajectory deflection on the incoming Compton particle and this effect constitutes the magnetic force. A stationary Compton particle on the other hand will not be affected by oscillating dipoles around it because in that case the attractive and repulsive effects caused by the oscillating dipoles average out as the asymmetry mentioned before is caused by the particle's movement. The stationary particle probably also moves slightly due to the nearby oscillating dipoles but still its mean position shouldn't change.

Please note that electromagnetism as proposed in this section should be invariant under a relativistic Lorentz transformation. Imagine putting two infinitely long conducting wires in parallel with electric current that flows in the same direction. These wires should be fixed firmly so that they hold their separation distance. In a frame that is at a fixed position relative to the wires a magnetic field can be measured but in a frame that is attached to one of the charge carriers there will be no magnetic field - only an electric field caused by the other charge carriers whose relative position offsets remain constant. Moreover the presented conception of electric and magnetic fields fulfils the requirement of special relativity theory that force must not cause instantaneous action over distance.

From what was professed here and in the previous sections it should be possible to deduce a new quantum physical formalism of electromagnetism that is primarily based on geometry, elementary dipoles, Compton particles, Planck units and a vacuum structure as introduced in section 3.8. The acceleration of charged Comtpon particles as stated in equations 4.11 and 4.22 should be a natural outcome of such a new quantum physical formalism of electromagnetism.

Photons are not be treated in this document because there are too many open questions about their nature. The expectation is however that photons are real particles which are also composed of PSUs so that they can carry momentum and have spin. The geometry and flow dynamics of photons should explain why they do not exhibit inertial mass but still interact with (entropic) gravity. Furthermore photons should be able to align witch each other and stick together to form electromagnetic waves. One geometry that might fulfil all these requirements is the torus and in analogy to Compton particle spin the photon's moment of inertia might be that of an infinitely thin loop.

The entropic gravity model and quantum electromagnetism as presented in this section might also be the starting point for electro-gravitic physics. If gravity and electromagnetism indeed function by influencing the vacuum PSU structure as presented in section 3.8 it might be possible to influence gravity through electromagnetism by deliberate engineering of electromagnetic fields.

5 DISCUSSION

This document mostly treated quantum physics in the original and literal sense, the physics of quanta, and it was demonstrated repeatedly that the properties of these fundamental quanta are given by the Planck units. Many of the equations presented in this document may be regarded as simplifications of the true situation but nonetheless interesting and useful results were obtained. Surprisingly it turned out that mass is not a fundamental quantity and what is denoted as (inertial) mass in physics seems to be emerging from the nature of Compton particles because if a Compton particle stopped spinning it would have zero mass according to the presented model. The constituents of a Compton particle, the PSUs, also possess energy which seems to be dependent on their rotation. Therefore mass should better be conceived as condensed energy or locked up energy. This line of thinking also implies that nothing in our universe could exist without rotation and subsequently it is paramount to understand our universe in terms of frequency and energy as suggested by Nikola Tesla. Charge on the other hand is a fundamental property because it cannot be explained in terms of something else and a PSU's charge can also only have two distinct values: positive or negative Planck charge.

Another realization is that the way our universe works is reminiscent of how computers create virtual realities. In this view the PSUs can be regarded as the voxels that make up our holographic universe whereas a voxel is similar to a pixel but it refers to 3D space instead of 2D space. Moreover the quantization of everything must also include time and using finite time slices is the usual way of doing computer simulation or discrete control engineering. Thus our universe might be regarded as an ingenious technology that is far more advanced than we can fathom whereas this statement does not imply that our universe is somehow "artificial" in the sense of unnatural.

Some of the parameters chosen for the presented models may not be fully correct yet and some of the ideas may also turn out to be wrong but overall the chosen approach seems to be promising. Many noteworthy relationships and interconnections were revealed which opens up a new perspective on particle physics, quantum physics, gravity and electromagnetism. The stated particle radii will certainly be a point of critique but the fact that the proton radius as stated by contemporary physics ($0.842\,\mathrm{fm}$) is 4.00 times larger than the one calculated in this document suggests that the presented concepts are relevant since the radius ratio is not some weird factor. Moreover the revealed symmetries between Compton particles, PSUs and black holes are remarkable and it would be surprising if they were all are meaningless.

The nature of our universe's fundamental forces as presented in this document deviates from the conventional view in physics. In particular it is sensible to assume that fundamentally our universe has to be conceptual but our everyday human experience of solid and massive objects obscures this realization. In accordance with this thinking it was proposed that the electromagnetic force is built on the concept of duality which is embodied on the physical level by the binary PSU charge. Please note that our whole reality would not exist without this fundamental duality since else Compton

particles could not coalesce, atoms would not form and consequently there would also be no molecules or biological life. Probably because of the fractal nature of our universe the concept of duality, or opposites, is reflected in all kinds of domains including human behaviour and philosophy. The gravitational force on the other hand is non-polar and purely attractive - or unifying in a more philosophical sense. It was proposed that the gravitational force emerges from thermodynamic and entropic considerations which are also fundamental concepts that are rooted in information theory. The thermodynamic relationship between Compton temperature and particle size is also logically sensible - a Compton particle gets hotter when it contracts and cooler as it expands. Moreover the rotation associated with Compton particles provides a quantum physical explanation for the equivalence principle of general relativity theory: as already mentioned inertial mass is presumably directly related to the relativistic Compton frequency whereas gravitational mass is implicitly related to it via the Compton temperature that depends on a particle's surface area which in turn is also governed by a particle's relativistic Compton frequency (see section 2.5).
Since gravitational and electromagnetic force have different conceptual causes it is likely not possible to unite their mathematical frameworks into one like it is possible with the electric and magnetic force which can be united into the electromagnetic force. Nonetheless it has been shown that on the PSU level gravitational and electromagnetic force are of equal strength and thus from a PSU's perspective there is only one quantum force. Another unification has been achieved with the strong force which seems to be gravitational in nature and according to this notion the strong force should be recognized as the near field behaviour of gravity. Moreover the previously mentioned proton radius discrepancy should be explainable by moving space around a Compton particle which makes it difficult to determine a Compton particle's exact boundary (see section 3.13).

On many occasions the presented material enters into the territory of special relativity and general relativity theory and some but not all of statements made in this document were in line with these theories. To assess this topic further it is important to note that special relativity theory makes two assumptions about our universe: there is no preferred inertial frame and there is no network of synchronized clocks but both assumptions should be reconsidered according to the findings presented in this document. In particular the crystal like vacuum structure as presented in section 3.8 constitutes a fundamental reference frame although it might not be a perfect inertial frame in case our universe is spinning and subsequently all of space would be subjected to the associated acceleration. It was shown that the crystalline structure of space is structured by octahedrons and there is also a conceptual reason why space should be defined by them: octahedrons are the simplest possible geometry which encodes three dimensional euclidean space because an octagon's contours are made from three orthogonal planes as can be seen in figure 10 *(thanks to Constantin Böhm for pointing this out)*. Furthermore the PSUs constitute a network of synchronized clocks across space and it could make sense to interpret time in terms of PSU and Compton particle frequency instead of an abstract dimension. This notion would also naturally explain the unification of local time and local space into so called space-time. It was already shown that the relativistic frequency of a Compton particle increases as it moves faster and therefore its ratio to the fixed PSU frequency changes. It is this changing ratio which may be responsible for what special relativity theory calls time dilation. The related effect of relativistic length contraction was already linked to the relativistic Compton frequency in section 2.5. Moreover the presented concepts presumed that Planck length l_l and Planck time t_l are fundamental quantities of quantized space-time which has a noteworthy implication: light speed $c = l_l/t_l$ should also be regarded as an emergent quantity.

The relationship of the presented material with general relativity theory is difficult to ascertain. Some of the presented work relies on the findings of general relativity theory - especially the black hole equations. On the other hand some of the presented findings oppose the notion of curved space. In particular Newtonian gravity could be retrieved by an entropic gravity model, the structure of space was proposed to be crystal like and even the constantness of the gravitational constant G has been challenged. A possible solution to this conflict has been proposed at the end of section 3.12: what appears as curved three dimensional space is actually the effect of a two dimensional vortex on the holographic surface of our universe whereby this two dimensional vortex is presumably linked to entropic gravity via temperature. The necessary mathematical link to general relativity theory seems to be the $8\pi G/c^4$ term in the Einstein field equations because:

- The G/c^4 term also appears in Newtonian gravity when reformulating it in terms of energy & temperature (see equation 3.75).
- The Planck force can also be expressed as c^4/G (see equation 4.4) and thus the G/c^4 term represents a link to the PSU properties.
- The $8\pi G/c^4$ term is linked to the measure of information N (see equation 3.37) and η_{sq} (see equation 3.52) because $8\pi G/c^4$ can also be expressed as $4\pi(2l_l^2)/(c\hbar)$ whereby $2l_l^2$ represents the PSU square area as depicted in figure 7.

Moreover the entropic interpretation of gravity also seems to fit naturally with the Compton particle model in addition to black holes which also suggests that the entropic gravity notion is preferable to the curved space view. Incidentally this concurrence also provides the long sought link between quantum gravity and gravity on cosmological scales.

Another deduction which is suggested by the presented material is that instead of aiming for higher dimensional models (4 or more) physics should rather try to find concepts that incorporate dimensional reduction to encode physical laws on the presumed holographic boundary layer of our universe. It was already shown that calculating Compton particle spin and magnetic moment involves two dimensional mathematics and the gravitational constant G can also be modelled as the effect of a two dimensional vortex. All of these findings may point towards the appropriateness of two dimensional physics at the fundamental level. Moreover the big bang model of our universe should also fit with the dimensional reduction idea because in case our universe can shrink again its holographic 2D surface would eventually vanish as our universe compresses back into a single PSU.

It has been shown that sensible variants of the Schrödinger equation exist which contain key properties of the presented concepts, namely Compton wavelength, Compton radius and black hole radius. This suggests that the presented models have merit and that there is a physical connection to the Schrödinger equation though this relationship may ultimately invalidate some of the contemporary interpretations of quantum physics. In particular the electric current density interpretation that Mills developed for the Schrödinger equation when it is applied to hydrogen is very compelling and there is evidence to believe that Mills is on the right track. He can calculate molecular bonding energies to a high degree of precision on normal computers with his software Millsian which is an extraordinary achievement. Moreover he predicted a new form of hydrogen with fractional orbital number n, i.e. $1/2, 1/3, ..., 1/137$, which Mills termed hydrino and he is already actively developing hydrogen based energy generation technology on this insight at his company Brilliant Light Power. In case Mills's interpretation of the Schrödinger equation is correct this implies that the commonly accepted probability based Copenhagen interpretation of quantum physics is inappropriate - the consequences would be manifold and difficult to assess because alternative explanations for experimentally verified quantum effects would be needed. According to Mills a cornerstone experiment of quantum physics, the Stern-Gerlach experiment, is also explainable by his model using the well established Maxwell equations of electromagnetism (4). Earlier attempts to find a classical explanation for the Stern-Gerlach experiment presumably failed because it was not conceived that the surface of a fundamental particle could be a complex and dynamic electromagnetic structure. Another important quantum physical phenomena, entanglement, could become explainable by further advances in holographic physics. The Bekenstein-Hawking entropy states that at most one fourth of the information present on a holographic boundary surface is linked to the information contained in the enclosed volume and theoretically this leaves plenty of information available for the purpose of quantum entanglement. One possibility is that the holographic surface stores redundant information which we perceive as quantum entanglement albeit this mechanism has to appear as non-local in 3D space to be consistent with Bell's quantum inequality.

Reflecting on the fundamentals of our universe also leads to an important philosophical insight: thinking that science can explain the mystery of existence and life is actually a fallacy. Ultimately our universe sprang from something we cannot fathom and unavoidably at some point the workings and properties of our universe cannot be explained any further from the within our universe. Moreover the systematic behaviour on the quantum layer and its degree of organization should be considered as engineering masterpiece that cannot be the result of chance and chaos. Thus it is only logical to assume that there must be a creator of some kind - even from the scientific perspective. On the human level this is reflected by the tendency of many humans to instinctively believe in a creator god although organized religion has often been a source of spiritual abuse. Despite this there might be some wisdom in the various spiritual traditions that is linked to what was presented in this document. For example the taoistic Yin and Yang is a reflection of the fundamental polarity that physics calls charge and the hermetic teaching "as above so below" can be understood as an allegory of a fractal universe. Moreover many ancient cultures were obsessed with pyramids which are halved octahedrons. Did these cultures build pyramids because it is a basic geometric form or did they consider this geometry to be sacred? The triangle which is an important component of the presented concepts is also found in several traditions. For example Hinduistic tradition states that the Kundalini energy is located in the sacrum bone which resembles a triangular shape. Morever Hinduism has a concept called trimurti and triangles also appear in Hindu iconography. Christianity on the other hand believes in the holy trinity which is often depicted as a triangle in paintings. Interestingly some translators think that god described himself to Moses as "I will become what I choose to become" in book Exodus (3:14) and as possessing "dynamic energy" in book Isaiah (40:26) which are peculiar wordings that may actually be related to physics. Furthermore the gospel of John states that ”in the beginning there was the word” and the Hindu tradition worships the syllable OM as the sacred primordial sound of creation. These statements may very well be allegories for vibration or oscillation expressed in words appropriate for the time they were initially written down and the reference to words also implies a deliberate creation act as words imply consciousness. Unfortunately our modern society exhibits a big division between physics, philosophy and spirituality which should be reconciled since all of these disciplines ultimately try to decipher the same mystery.

6 CONCLUSIONS

The material presented in this paper has demonstrated that the work of Horst Thieme, Nassim Haramein, Randell Mills and Erik Verlinde can be combined and extended into a novel holo-fractal quantum physical perspective on our universe.

Holographic because the Bekenstein-Hawking entropy, which is the prime characteristic of the holographic principle, is governing the self energy of Compton particles & black holes (see section 3.9) and because several fundamental quantities can be described by two dimensional equations which hints towards an underlying two dimensional holographic nature. As shown in section 3.14 our local Hubble sphere qualifies as Schwarzschild black hole which is also further evidence for the universal applicability of the holographic principle. Moreover evidence was presented which suggests that gravity is actually entropic in nature (see sections 3.7, 3.9 & 3.10) and this view of gravity is conceptually a natural fit with the holographic principle since both concepts deal with information and entropy.

Fractal because similar design principles can be found at different scales of our universe, in particular the concept of spheres, and because Compton particles & black holes were shown to be akin as described in sections 3.3 & 3.5. Moreover biological life depends on eggs and cells which can be regarded as another expression of the fractal universe notion as every one of these entities constitutes its own biological universe.

Quantum because everything in our universe comes in chunks - even time and space whereby the latter presumably is a crystal like structure which is composed of PSUs (see sections 3.5 & 3.8). The quantities of these chunks are defined by the Planck units as repeatedly demonstrated throughout this document. Moreover section 4.6 suggested how electromagnetic fields can be modelled in a quantum physical way which is consistent with the presented material and also incorporates the PSUs.

Several unifications were outlined in this paper: various fundamental particles were described by the Compton particle model (see all of section 2), the very large and the very small were put in a common framework (section 3.3 & 3.5), the strong force was ascribed to gravity (section 3.13) and electric & gravitational force were shown to be equal at the PSU level (section 4.1). In addition to that section 2.10 demonstrated that the Compton particle model may be extended to hydrogen.

In general, the presented work suggests that although our universe is seemingly governed by chance and chaos there is incredible systematics and interconnectedness beyond it all. Lots of open questions remain, and despite its length this paper still only touches all the various subjects on the surface, but the stated results and revealed relationships should be interesting enough to substantiate the presented thinking and encourage further research.

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  http://resonance.is, http://brilliantlightpower.com
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  http://smath.com
- Images of platonic solids were created with ”Great Stella” which is provided by Robert Webb.
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