Towards a Self-Consistent and Controllable Graviton Flux

A new Strategy to Compare Different-Dimensional Fluxes via Unit Scale Reference

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Abstract. The long standing hierarchy problem in particle physics addresses the 19 orders of magnitudes difference in interaction between electromagnetic forces and gravitation. Referring to string and conformal field theories it is commonly agreed that the weakness of gravity can in general be assigned to extra-dimensions (holographic principle). But there are no practical rules regarding dimensional adjustments and proper dynamic scaling improving the coupling of fields with different dimensionality, i.e. transforming electromagnetic flux into higher-dimensional gravitational fields for space propulsion purposes. Regarding the flux volume there is in any case a characteristic power-law scaling between length and time or mass scales with exponent proportional to the number of spatial dimensions. As a requirement of unification and adjustment, power-laws with different exponents should intersect at the unit scale since any power of 1 is 1. The basic reference and gravitational unit scale is given by a Kepler dynamics with unit radius and unit angular velocity that can be assigned to a gravitational unit source $|m_G| = |4\pi^2/G|$. At this scale topologically different fields, sources of interaction and correspondent characteristic length and mass scales can be compared via Gauss law, where a quantum flux number N_G connects the unit scale and the quantum scale. In our System of Units (SI) $N_G \propto c^4$ can be found by dividing the unit length by the Planck length, consequently N_G measures the weakness of gravity at the unit scale, where the Compton photon scale is given by the geometric mean and inversion symmetry between the unit and the Planck scale. Fields of applications could be in solid state superconductors (exotic materials) able to host high-dimensional network flux topologies with proper scaling and dynamics.

Keywords: graviton, quantum, brane, field, Gauss, extra dimension, AdS/CFT-correspondence, holography, units, flux
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INTRODUCTION

Understanding the weakness and nature of gravity is crucial in evaluating the possibility, efforts, and limits to “engineer” and control gravity in the laboratory on the road towards new propulsion techniques. In modern theories Gravity is in general allowed to propagate in extra dimensions (Arkani-Hamed et al., 2000, Aharony et al., 2000). Because of this extra-dimensional topology we feel only a small projection (the Newton gravity) of the total flux in our 3-dimensional world ($d = 3$). Topological shifts induced by extra dimensions change the characteristic exponents of the power-law mass and length scaling. Power-laws show in contrast to exponential-laws scale-invariance without special length scales. Searching for length references there are two scales that seem to be fixed and robust against topological shifts: the Planck scale and the unit scale. In the last hundred years the Planck scale has become the fundamental scale for theoretical investigations while the unit scale was primarily only necessary for practical purposes. From a mathematical viewpoint the unit scale has no special meaning. But if we want to connect different scientific disciplines that are often grouped and separated according to their topological background it is the common unit scale that can build the bridge between the scaling laws of different fields. We can be sure that any radial power law with or without extra-dimensions will intersect at this scale. Defining the corresponding unit fields and unit scale Kepler dynamics will be done in the first part of this paper. We will then define the quantum fields and fluxes and get a number scaling by dividing the unit scale flux source into a number of quantum sources carrying a spin quantum. Finally, we will verify via Gauss law the quantum flux topology and radial scaling of n-sphere surfaces with corresponding scaling exponents and discuss a practical example.

BACKGROUND

To access and control the flux in the 4th spatial dimension (that flows through a 3-hypersurface or 3-brane) it is important to understand the higher-dimensional flux topology. A higher dimensional structure can be encoded in a lower dimension. This is the well know holographic principle, in the context of gravity proposed by Stephens and 't Hooft et al. (1994) and later improved by Susskind (1995). This was a conceptual breakthrough in theoretical physics. The most successfully tested realization of the holographic principle is the so-called AdS/CFT correspondence (Malcadena 1998, Witten 1998). It is the equivalence between a quantum gravity or string theory defined in a d-dimensional world or spacetime (like a sphere or Anti-de Sitter space AdS), and a conformal field theory (CFT), a quantum field without gravity defined on the $d-1 = n$-dimensional conformal boundary of this space. Randall and Sundrum (1999) considered the observable universe as a subspace of the AdS braneworld that consists of a bulk AdS_{d+1} space ending on a $d-1 = n$-dimensional domain wall, or brane, for $d = 4$ referred to as a 3-brane. For our purposes we will also have one spatial extra dimension $d = n + 1 = 4$ but we won't need the AdS level of complexity. Recently Seahra (2005) has pointed to static and spherically symmetric Schwarzschild solutions of the Einstein-static universe with one extra dimension, essentially 4-dimensional black holes bounded by spherical hypersurfaces S_3, spherical 3-branes. The quantum projections of a 4-dimensional black hole are quantum holograms in the AdS-Schwarzschild 3-braneworld (Emparan et al., 2002). This means that the hologram provides for a number of irreducible quantum units (strings or 1-branes, in the Schwarzschild case S_1-rings) carrying a spin quantum. In this paper the correspondent power-law scaling providing for the number of quanta will be obtained and related to the value of the Newton gravitation constant G that defines the unit scale intersection. The holographic principle introduces a degree of quantum non locality into gravity that could lead to instability. To get the necessary stability we assume that the underlying graviton flux represents a self-consistent or self-regenerating quantum hologram with backreaction.

STANDARD MASS-DISTANCE SCALING

With spherical symmetry (radial potential) in 3-dimensional space the general scaling behavior and dynamics follows Kepler's third law that holds even at the strong field regime where general relativistic red-shift terms become dominant (Misner, Thorne, and Wheeler, 1973). The Kepler scaling can be exactly described by

$$Gm = rv(r)^2 , \tag{1}$$

where m is a gravitating mass, r the radial distance, and $v(r)$ the orbital velocity. For the 4-dimensional Schwarzschild solution with weak field observer coordinates (distant observer) the red-shift term $1/(1 - r_S/r)$ provides for a singularity near the Schwarzschild radius $r = r_S = 2Gm/c_0^2$ known as the black hole horizon with light velocity c_0. Looking for scaling references the most interesting radius is given by the Schwarzschild photon sphere radius $r = \rho$ with

$$3Gm = \rho c_0^2 = \tfrac{3}{2} r_S c_0^2 . \tag{2}$$

Here space is curved to a closed sphere (umbilical surface), photons are captured on circle orbits, and the red-shift term equals 3. What has a 3-brane and extra dimensions to do with the photon sphere? The photon sphere brane geometry corresponds to projections that have been recently found by a non-standard slicing of 5-dimensional Schwarzschild-AdS manifolds as a 4-dimensional projection of the 5-dimension bulk based on isotropic coordinates with extrinsic curvature proportional to the induced metric. This represents a brane sourced by a cosmological constant only (i.e. by tension, Seahra, 2005). This is exactly what we need for the following considerations.

GENERAL MASS-DISTANCE SCALING

Equations (1) and (2) provide for references at the weak and strong field range, where it is expected that the strong field limit at the small scale is not only subject to relativistic effects (red-shift) but also to topological changes based on a dimensional reduction. This effect can be characterized with a power-law relation between mass as the source of a gravitational flux m, the black hole horizon or area A, and radius r

$$m \propto A^{e/2} \propto r^e \, , \tag{3}$$

e = 1 corresponds to the standard Schwarzschild case, see Figure 1. The exponent e provides for the spatial flux scaling and decides whether the black hole is in thermal equilibrium or not (Chatterjee and Majumdar, 2004). Extra-dimensions provide for cooling since e < 2 signifies a thermal instability, generic non-rotating AdS black holes have e > 2. Ignoring the complex geometry of higher dimensional black holes we will look at the rather simple spherical symmetric AdS-Schwarzschild black hole in four spatial dimensions with $e = 3$.

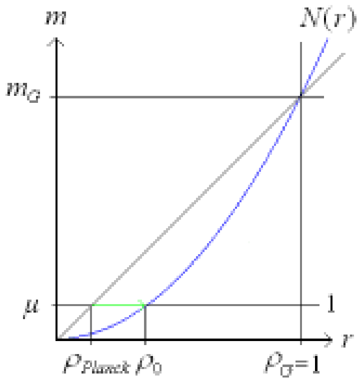

FIGURE 1. Intersection at the unit scale $|\rho_G| = 1$, quadratic number scaling $N(r)$ (blue), and Planck scale shift (green arrow).

THE UNIT SCALE AND UNIT FIELD GENERATING MASS

With the Kepler scaling in (1) there is one mass m_G at the macroscopic scale we will call the unit field generating mass that generates SI unit Kepler orbits or clocks with radius 1 meter and period 1 second (Binder, 2003). Extra dimensions contribute to the exponent of the power-law radial scaling of the AdS bulk mass in (3). With $m = m_G$ radial power laws with different exponent will intersect at the unit scale $\rho_G = 1$ meter since powers of ρ_G have the unit value. Therefore, m_G allows to approach and quantify the extra-dimensional flux and to compare the characteristic exponents and scales. At this scale we have with (1)

$$G m_G = b \rho_G {c_G}^2 \, , \tag{4}$$

where $b = 4\pi^2$ is a SI factor carrying information about the geometrical symmetry/setup for a circular Kepler orbit in the weak field limit with 1 second period and orbital velocity $v = 2\pi c_G = 2\pi \mathrm{ms}^{-1}$.

THE NUMBER SCALING OF SLICES

We have seen in (3) that extra dimensions contribute to the exponent of the power-law radial scaling of mass. The Bekenstein-Hawking bound (Bekenstein 1973, Hawking 1974) for brane holography implies that the number of degrees of freedom (1 degree of freedom per Planck area) inside some region grows as the area of the boundary of a region and not like the volume of the region (see i.e. Aharony et al., 2000). With this bound we will check the mass-number scaling of a 3-brane via surface area S_3, where we will quantize the total flux into a sum of N 1-branes with surface area S_1. We expect that the mass or source ratio equals the flux ratio and divide m_G into quantum slices that correspond to N_G quantum flux states based on the mass ratio, where μ are lower-dimensional the mass quanta part of m_G

$$k N_G = \frac{m_G}{\mu} \, . \tag{5}$$

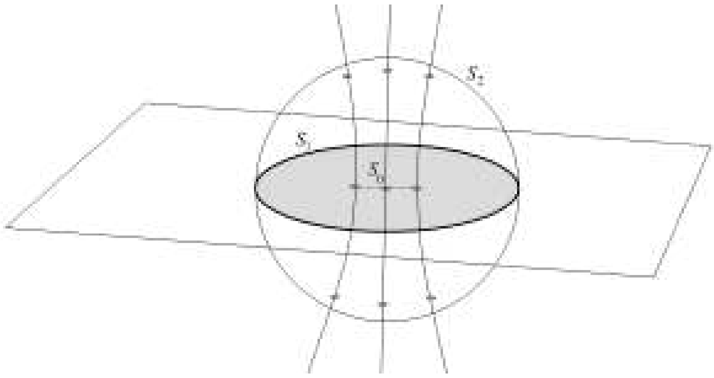

FIGURE 2. A flatland visualization with 2-dimensional gravity and one extra dimension.

The number will be found from the black hole flux topology that depends on the Bekenstein-Hawking surface area law (3), where the entropy and corresponding number of quantum states on the brane can be counted provided that we have the correct surface topology. Another dimensionless number is *k*, it will show the difference in flux topology. With $k = 1$ we would have the same flux topology on both scales, the macroscopic bulk scale and the microscopic quantum scale. Since the flux will be perpendicular to the surface and proportional to the mass we can calculate from Gauss law the flux number as the ratio of the bulk source mass to the quantum source (5). S_n will be the surface of a *n*-sphere with fixed radius $r = \rho_0 / \rho_{Planck}$ embedded in Euclidean space with dimension $d = n + 1$. The radial scaling of area in (3) and *n*-sphere surface provides for $n = e$. The high-dimensional surface embedded in 4 spatial dimensions representing the AdS-Schwazschild bulk flux topology is S_3, the low-dimensional quantum surface topology constraining the standard Schwarzschild photon sphere flux at the Planck scale will be the ring geometry S_1. Therefore we assume that the Gauss flux ratio equal to the mass ratio is given by the ratio of a *n*-sphere surface to a *n*-2-sphere surface with $n = 3$ where

$$kN_G = \frac{S_n}{S_{n-2}} = \frac{2\pi}{n-1}\left(\frac{\rho_0}{\rho_{Planck}}\right)^2, \; S_n = \frac{(n+1)\pi^{(n+1)/2}}{\Gamma(\frac{n+1}{2})}\left(\frac{\rho_0}{\rho_{Planck}}\right)^n. \tag{6}$$

Examples are $$S_1 = 2\pi\frac{\rho_0}{\rho_{Planck}}, \; S_2 = 4\pi\left(\frac{\rho_0}{\rho_{Planck}}\right)^2, \; S_3 = 2\pi^2\left(\frac{\rho_0}{\rho_{Planck}}\right)^3, \; S_4 = \frac{8\pi^2}{3}\left(\frac{\rho_0}{\rho_{Planck}}\right)^4. \tag{7}$$

kN_G counts the flux ratio between the global and local flux in Planck units in accordance with the holographic picture of string theory, so it simply measures the flow of quantum Bekenstein-Hawking entropy or holographic 't Hooft-Susskind information on the human artificial unit scale. For this section we conclude that a global flux in $d = 4$ passing a 3-dimensional surface is composed by a number of quantum fluxes in $d = 2$ connecting a 1-dimensional ring boundary, where the Newton coupling happens in $d = 3$. A simple flatland scenery with global flux in $d = 3$ is sketched in Figure 2, where the coupling happens in $d = 2$ between points, a 2-dimensional gravity with one extra dimension. Adding one dimension would correspond to our model. The flux lines along the extra dimension are perpendicular to the 2-dimensional world sheet, where the circle S_1 represents the surface of the unit disc (grey).

PLANCK SCALE QUANTUM CONDITION

Counting lower-dimensional fluxes embedded in a higher-dimensional topology can be related to quantum flux properties and conditions. The photon sphere limit is a proper candidate for a low-dimensional reference topology that can be assigned to a spin and a mass quantum. For this purpose we can connect the quantum mass scale μ to a length scale given by the photon sphere radius ρ_0 that is obtained by inserting the unit field generating mass into eq.(2). We expect a quantum spin condition involving the light velocity c_0 and the Planck constant $\hbar$

$$\mu c_0^2 = \frac{hc_0}{\rho_0} = 2\pi \frac{\hbar c_0}{\rho_0} . \quad (8)$$

The Kepler scaling (2) defines at the strong field (Compton) scale with a relativistic factor $a = 1/3$ according to (2)

$$Gm_G = a\rho_0 c_0^2 . \quad (9)$$

For $e = n = 3$ we expect from (6) $k = \pi$ and $N_G = \left(\rho_0 / \rho_{Planck}\right)^2$. The correspondent Planck scale condition requires

$$|\rho_0| \to |\rho_{Planck}| \to 1 \text{ and } N_G \to 1 \text{ for} |c_0| \to 1 . \quad (10)$$

Inserting these constraints allows to calculating N_G and to verify our setup. To determine the quantum scale we have with (5-9) the typical Planck scale energy relation

$$\frac{1}{a}\frac{Gm_G \mu}{\rho_0} = \frac{k}{a}\frac{GN_G \mu^2}{\rho_0} = \frac{k}{a}\frac{G\sqrt{N_G}\mu\sqrt{N_G}\mu}{\rho_0} = \mu c_0^2 = \frac{hc_0}{\rho_0} . \quad (11)$$

To be compliant with (10) the Planck scale (Planck length ρ_{Planck}, see Figure 1) with symmetric Planck interaction mass m_{Pl} will be with (11) defined by

$$\rho_{Planck} = \frac{\rho_0}{\sqrt{N_G}} = \sqrt{\frac{kGh}{ac_0^3}} , m_{Pl} = \sqrt{N_G}\mu = \frac{h}{\rho_{Planck} c_0} . \quad (12)$$

With eqs.(4) and (9) we find

$$\rho_0 = \rho_G \frac{b}{a} \frac{c_G^2}{c_0^2} , \quad (13)$$

the photon sphere limit, and with (12)

$$N_G = \frac{\rho_0^2}{\rho_{Planck}^2} = \left(\frac{b}{a}\right)^2 \frac{c_0^4}{c_G^4} = \frac{\rho_G^2}{\rho_0^2}\left(\frac{b}{a}\right)^4 . \quad (14)$$

(12) reveals an inversion symmetry between the unit scale ρ_G and the Planck scale ρ_{Planck} at ρ_0 given by

$$a\rho_0 = b\sqrt{\rho_G \rho_{Planck}} . \quad (15)$$

The quadratic scaling (12) and (14) as a consequence of (6) has also been found by others (Sidharth 2004). Since ρ_0 is inversely proportional to the square of the light velocity and ρ_G always gets the unit value, we have from (15) a Planck length that is inversely proportional to the fourth power of the light velocity

$$\rho_{Planck} = \left(\frac{b}{a}\right)^2 \frac{\rho_G}{N_G} = \frac{\rho_G}{|c_0^4|} , \quad (16)$$

where $|\rho_{Planck}| \to 1$ for $|c_0| \to 1$ as desired in (10). Planck constant allows us to determine the Newton constant

$$G = \left|\frac{a}{c_0^5 h}\right| \mathrm{m^3 s^{-2}} = \frac{\rho_{Planck}^2}{\rho_0^2}\frac{b}{k\mu}\mathrm{m^3 s^{-2}} = \frac{\rho_0^2}{\rho_G^2}\frac{a^4}{b^3 k\mu}\mathrm{m^3 s^{-2}} = \frac{\rho_{Planck}}{\rho_G}\frac{a^2}{bk\mu}\mathrm{m^3 s^{-2}} = \frac{1}{N_G}\frac{b}{k\mu}\mathrm{m^3 s^{-2}} . \quad (17)$$

At the Planck scale limit with $|\rho_{Planck}| \to 1$, $|\mu| \to 1$ for $|c_0| \to 1$ we have

$$|Gh| \to a\,,\ N_G \to \left(\frac{b}{a}\right)^2,\ |G| \to \frac{a^2}{b}\,,\ |h| \to \frac{b}{a}\,. \tag{18}$$

SI UNIT SCALE RESULTS

Extrapolating and connecting the macroscopic unit scale intersection to the microscopic Kepler photon scale limit (13) with quantum mass and spin condition (8) we only have one degree of freedom given by the value of the light velocity c_0 that is exactly defined by the SI-system (Groom et al., 2000) $|c_0|$=299792458. To obtain a good result for N_G according to (6) and (14), we have to set $k = \pi$ with $n = 3$, where $a = 1/3$ and $b = 4\pi^2$. The scaling number allows with eqs. (14)-(18) to calculate baryon masses and the gravitational coupling strength either by dividing the macroscopic unit field bulk mass by N_G or alternatively (since *G* is only known to about 4 decimal digits) we can obtain the quantum mass via quantum flux condition given more precisely by using the Compton relation (8) on the photon sphere. Since we have ignored secondary coupling effects and defects it is interesting to compare results with measurement (see Table 1 below).

TABLE 1. Measurement – Calculation for $a = \frac{1}{3}$, $b = 4\pi^2$, $k = \pi$, $|\rho_G| = 1$, $|c_G| = 1$.

Constant	Context	Measured	Calculated	Difference
$b/a = 12\pi^2$	eq.(4), (9)	118.762	118.435...	0.276%
ρ_0	eq.(8), (9), (13)	$1.3214 \cdot 10^{-15}$ m	$1.3177 \cdot 10^{-15}$ m	-0.276%
μ proton	$h/\rho_0 c_0$	$1.67262 \cdot 10^{-27}$ kg	$1.67724 \cdot 10^{-27}$ kg	0.276%
μ neutron	$h/\rho_0 c_0$	$1.67493 \cdot 10^{-27}$ kg	$1.67724 \cdot 10^{-27}$ kg	0.138%
N_G	eq.(5), (6), (14)	$\approx 1.1226 \cdot 10^{38}$	$1.13304 \cdot 10^{38}$	0.932%
G Newton Gravitation Constant	eq.(17)	$\approx 6.6742 \cdot 10^{-11}$ kg^{-1}m^{3}s^{-2}	$6.6125 \cdot 10^{-11}$ kg^{-1}m^{3}s^{-2}	-0.924%
m_G	eq.(5), (9)	$\approx 5.915 \cdot 10^{11}$ kg	$5.97022... \cdot 10^{11}$ kg	0.932%
ρ_{Planck}	eq.(12), (16)	$\approx 1.244 \cdot 10^{-34}$ m	$1.23799 \cdot 10^{-34}$ m	-0.463%

The m_G measurement value is about 0.932% smaller than the calculated value based on N_G, where we have assumed a weak coupling without mass defect. Strong coupling shows nuclear mass defects that are in this range, see Table 2. Measurements of *G* are usually performed with lead as the dominating gravitating material.

TABLE 2. Bulk NMD (Audia et al., 2003).

Material	Abundance	Defect
Lead	100% 207Pb	0.85%
Iron	100% 56Fe	0.95%
Oxygen	100% 16O	0.86%
Earth	13% 24Mg, 15% 28Si, 30% 16O, 35% 56Fe	0.89%

POSSIBLE APPLICATIONS

The low-dimensional dynamics on bulk system scale of the 3-brane will always depend on the unit Kepler scaling (4). By Keplers third law the value of the unit field generating mass is proportional to the square of the angular frequency and to the cube of the unit size. Here is an interesting example demonstrating the holographic scaling, coupling, and dynamics of a solid-state universe:

Set the macroscopic holographic relaxation or unit time scale to $t_G = 0.1$ millisecond, macroscopic autocorrelation length scale to $\rho_G = 0.1$m, consequently $m_G \approx 0.59$kg see (4). This system would have a unit or correlation velocity near $\rho_G / t_G = 1000$ m/s, frequency $t_0 \approx 10^{-19}$ s, symmetric Planck mass interaction sources $\sqrt{N}\mu \approx 10^{13}\mu \approx 10^{-14}$ kg firing on the electromagnetic level, 100 mole $N \approx 10^{26}$ quantum gravity channels with photon sphere size about $\rho_0 \approx 10^{-10}$ m. The geometric mean of the unit and Planck time scale $t_0 \approx \sqrt{t_{Planck} t_G} \approx 10^{-19}$ s can according to (15) be assigned to a (Compton) scattering frequency, a fluctuation-dissipation relaxation time scale with excitation energy $\Delta E \approx h / t_0 \approx 10$ keV. Photons are trapped on photon sphere surfaces defined by solid state molecular zones exited in the X-ray range. Since ρ_0 is a Compton length this setup could eventually be driven by 0.1 millisecond X-ray pulses via inverse Compton scattering with photons pumped by a CO_2 laser somehow breaking the symmetry.

Such a closed holographic universe pumping (encoding) extra-dimensional flux patterns could obviously be realized by semiconductors and/or nano-techniques but maybe also by short-time coherent biological processes. Robertson (2005) discussed how to manipulate the vacuum scalar field with superconductors or "exotic materials". Here $t_0 \approx \sqrt{t_{Planck} t_G}$ corresponds to the Ginzburg-Landau free energy freeze-out time. The main condition for our considerations is that the low-dimensional brane-projections provide for the necessary metrics and dynamics adjusted to the supergravity hyper-impedance of the 3-brane bulk that follows the unit Kepler scaling in eq.(4). It is interesting to note that the unit scale numbers in the example above can also be quite well found in a human or animal brain. Similar to the dynamics of the example above a number of Planck mass brain neurons ($\approx 10^{13}$) interacting with a symmetric partner (maybe the two halves) with the square number of molecular quantum flux channels ($\approx 10^{26}$) providing for a holographic relaxation frequency $1/t_G$ in the kilohertz range that defines the macroscopic reaction timescale as a manifestation of a holographic interaction encoding the extra dimension. It was already conjectured by Pribram (1971) that memories are encoded not in single neurons, or small groupings of neurons, but rather non-locally in a hologram (on the brane). If neuronal network configurations like the human brain act like a *d*-brane baby universes they would be a priory capable to couple to extra dimensional graviton flux and might also produce a net acceleration force for highly advanced propellant-less space propulsion engine cycles. In any case, propulsion by brains would surely not be the optimum solution. Important is a spatially extended anisotropic exchange of momentum signals with the correct dynamic and number scaling.

CONCLUSIONS

We can verify in spherical symmetry that topologically different sources of interaction and correspondent characteristic length scales can be compared applying Gauss law at the unit scale, where any geometric radial power law flux and correspondent mass-energy scaling will intersect. We find a high consistency in the values if we take for the bulk mass a 4-dimensional AdS-Schwarzschild braneworld topology and for the quantum mass a 2-dimensional photon sphere topology, a quantum string excitation carrying a spin quantum. m_G defines the SI-unit scale where we can obtain the characteristic number of dimensions and number of quantum states, see Figure 1. The Gauss flux number N_G constitutes the total 3-brane unit flux and can be written in terms of the number of quantum strings or 1-branes that are part of the 3-brane surface in Planck units (Bekenstein-Hawking) in accordance with the holographic picture ('t Hooft-Susskind) of string theory. Therefore, N_G can be assigned to the quantum entropy or holographic memory of the SI unit scale. The quantum mass μ providing for gravitational flux quantum is very near to the baryon masses, where we find a μ-neutron-proton mass sequence with interesting steps of about 0.138% deficit (see Table 1) that will be treated elsewhere. The deficit in m_G could be assigned to a secondary type of interaction, where the value of mass defect (0.9%, see Table 2) fits very well to nuclear interaction, a kind of local gluing of brane surfaces reducing the total brane surface and flux. In any SI-type system of units G or m_G can be related via N_G to μ, with (8) the value of h can be directly related to μ. The shift in dimensionality leads to a shift in characteristic scales. The Planck scale is not a fundamental length and depends on the SI length and time units (13). This means that the classical limit corresponds to systems where the Planck length goes to zero, the value of the light velocity and N_G go to infinity, and where the time unit is infinitely long. This holds for any system of units with unit field generating mass and N_G defined according to (5).

NOMENCLATURE

c_0 = Light velocity (299792458 m/s)
m_G = Unit field generating bulk mass (kg) see Table 1

N_G = scaling number characterizing a SI-type System of Units, see Table 1
m = mass (kg)
k = topological factor
μ = quantum baryon mass (kg), see Table 1
t_0 = small scale diffusion time scale (s)
t_G = unit time scale (s)
t = time (s), T_{Planck} = Planck time (s) = ρ_{Planck} / c_0
f = frequency (Hz) or (1/s)
r = distance (m)
r_s = Schwarzschild radius, black hole horizon
ρ_0 = strong field inversion scale, photon sphere radius, Compton length, diffusion length (m)
ρ_G = unit length scale, weak field or big scale distance (1m)
ρ_{Planck} = Planck length ($1.23799 \cdot 10^{-34}$ m)
CFT = Conformal Field Theory
AdS_5 = 5-dimensional Anti de Sitter space
S_n = n-Sphere, spherical surface embedded in $d = n+1$ Euclidean dimensions
SI = System of Units
G = Newton Gravitation Constant (6.673 10^{-11} $m^3/s^2/kg$)
h = Planck Action Quantum (6.62607 10^{-34} kg m^2/s)
NMD = Nuclear Mass Defect

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