Title: Addressing Anomalies in Extreme Cosmic Environments: A Fatio/Le Sage Push-Gravity Approach.

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Abstract

This study investigates the efficacy of the Fatio-Le Sage push-gravity model in explaining phenomena that traditional models struggle to resolve. Objections to push-gravity are overcome without violating causality. The 'Quantum Vacuum Inertia' of Alfonso Rueda and Bernard Haisch offers an electrodynamic model for the dynamic aether as an isotropic radiant energy density. The correlated 'Photon Pairs' of Patrick Grahn, Arto Annila, Erkki Kolehmainen shows matter to be mostly transparent to the aether and offers a transformation mechanism whereby the 'energy problem' is avoided. Newtonian gravity is derived from first principles, which reveals an exponential component that conflicts with Standard Cosmology, yet bears solutions to some current cosmic anomalies. The findings might be directly applicable to improve existing gravity models, including relativistic models, and the resultant equations reveal the beginnings of a path to a quantum solution.

Introduction

The ZPF of Alfonso Rueda and Bernard Haisch

From the above authors and their 2005 paper 'Gravity and the Quantum Vacuum Inertia Hypothesis'[1] we build on the following findings and principles:

- A dynamic aether, or in their words, a quantum vacuum, or Zero Point Field (ZPF), exists which consists of an isotropic radiant energy density.
- The full strength of the aether is yet undetermined and only fractionally observed manifesting as inertial and gravitational mass.
- Mass arises when objects of charge, including neutral particles with fundamental charge subcomponents, are accelerated within the aether.
- Inertial mass and gravitational mass are equal, and both are the same effects of interactions with the aether.
- Energy, even in the equation $E=mc^2$, is associated with the particle but originates from the aether. In this case E does not represent the full strength of the aether but only the fraction that interacts with the object to reveal mass 'M'. Rueda and Haisch place a limit on this interaction with the coupling η where $0 \le \eta \le 1$. We further conclude that since mass shielding is not an obvious phenomenon that $\eta \ll 1$.
- The Lorentz factor 'γ' represents a velocity frame relative to an isotropic aether.
- The energy absorption for an accelerated object is not instantaneous, but limited to the size of the force, or the gradient of aether asymmetry; the object will absorb energy at a limited rate while there is an asymmetry. We expand on this. Mansuripur[2] and Pfeiffer[3] write that photons do not apply a force but impose a velocity (or transfer momentum).

We differ from the proposals of the authors in that while we acknowledge the aether must contain random collections of left-over or distant electromagnetic radiation (EM), their proposed photon mode does not lend to transparency of ordinary matter and may not lead efficiently to the concept of mass and gravity for composite masses.

We thus propose the primordial photon flux to consist of neutral correlated photon pairs, of a specific monochrome energy, such to observe consistent charge, mass and gravitation from its interaction with objects of mass.

Photon pairs of Patrick Grahn, Arto Annila, Erkki Kolehmainen.

The vacuum contains a dynamic aether: an isotropic radiant energy density of photon pairs. To describe these photons and pairs, we introduce a new internal tag that determines the sign of each (real, not virtual) photon's contribution to the classical electromagnetic field. We label this tag the **"photon EM charge."**

- $\mid R_+\rangle$ describes a right-circular polarized (RHC) photon with photon EM charge $+1$ and spin angular momentum $+\hbar$ along its momentum.
  Similarly, $\mid R_-\rangle$ is an RHC photon with photon EM charge -1 and spin $+\hbar$.
- $\mid L_+\rangle$ describes a left-circular polarized (LHC) photon with photon EM charge $+1$ and spin angular momentum $-\hbar$ along momentum.
  $\mid L_-\rangle$ is an LHC photon with photon EM charge -1 and spin $-\hbar$.

We use $\mid RR\rangle$ as shorthand for the two-photon state $\mid R\rangle \otimes \mid R\rangle$, meaning both photons are in the RHC polarization state. $\mid RR\rangle$ has a definite spin projection $\langle \hat{S}_z\rangle = +2\hbar$; $\mid LL\rangle$ has spin projection $\langle \hat{S}_z\rangle = -2\hbar$. A notation $\mid RR\rangle$ does not specify the photon EM charges but could represent $\mid R_+R_+\rangle$, $\mid R_-R_-\rangle$, or a superposition. For a pair with opposite photon EM charges, we write $\mid R_+R_-\rangle$ or $\mid L_+L_-\rangle$; the assignment of $+$ or $-$ to a given photon is arbitrary, as only the relative sign matters.

Despite the unconventional photon EM charge label, the inner products remain conventional: $\langle R \mid R\rangle = 1$, $\langle L \mid L\rangle = 1$ for any combination of photon EM charges, ensuring normalisation.

From these states we construct the **"dark" photon pair** that pervades space — a superposition of $\mid R_+R_-\rangle$ and $\mid L_+L_-\rangle$. This represents the superposition of photon pairs proposed by Grahn, Annila and Kolehmainen[4], which have no measurable classical electromagnetic field because the oppositely rotating fields of the $\mid R_+R_-\rangle$ and $\mid L_+L_-\rangle$ pairs components interfere destructively on average. With net spin $\langle \hat{S}_z\rangle = 0$, the pairs are undetectable by standard electromagnetic and QED means:

$$|s\rangle = \frac{1}{\sqrt{2}}(|R_+R_-\rangle + |L_+L_-\rangle)\,, \langle s|\hat{S}_z|s\rangle = 0\,, \langle s|\hat{E}^+|s\rangle = 0 \qquad (1)$$

These photon pairs have a large penetration depth into ordinary matter, interacting only via a small cross-section determined and scaled by the material coupling η. This makes atomic matter nearly transparent to the photon pairs.

Differing from Grahn et al., we thus propose that photon pairs do have a small probability to interact with fermions via a coupling factor η — related to the mechanism identified by Rueda and Haisch for the emergence of mass. Upon interaction, a pair collapses from the superposition $|\, s\rangle$ into, for example, $|\, R_+R_-\rangle$, which remains electromagnetically dark (zero net E and B fields because the photon EM charges are opposite), but it now carries a bright spin $\langle\hat{S}_z\rangle = +2\hbar$ available for spin-spin interaction with matter.

[Figure 1] shows a composite mass is ‘at rest’ in a 1-dimension dynamic aether, with ‘at rest’ understood as there being no asymmetry in the fluence rate from any direction, i.e. the energy flow is macroscopically equal from all sides, and no net momentum is imposed on the mass. Since mass is mostly transparent to aether, aether flows into a composite mass from all directions, and as we will show, primordial photon pairs flow out the opposite side at a reduced rate.

The proposed aether is a dynamic stochastic background, and not to be confused with the static aether theory of Lorentz[5], nor with the corpuscles of the push-gravity theories of Fatio and Le Sage[6-13], although the latter provided much inspiration toward this hypothesis.

Photon-pair transformation from primordial photon pairs to electrostatic fields

All subatomic particles of charge, and composites there-of, transform a fraction of the primordial energy as it transitions the object. We also conclude from Rueda and Haisch that this fraction η of transformation is what gives the object the property of mass. It is speculated by Zinserling[14] , with some dubious formalism, that the superposition of eq(1) collapses into defined states |RR⟩ and |LL⟩, which interacts with particles of charge. Restated here with renewed clarity:

When a dark photon pair $|\, R_+R_-\rangle$ encounters e.g. an electron e^- at rest with a spin favourable to the action, the R_- photon interacts via spin–spin coupling with the electron, imparting a forward impulse of magnitude $\Delta p = \eta P_{\mathrm{R}}$. This makes the electron ‘loaded’ with the R_- photon and prepared for a stimulated emission event. While the electron is in this loaded state, its electric charge mediates a transformation of the accompanying R_+ photon into an R_- photon, flipping its EM photon charge while preserving its energy and helicity. The newly created R_- photon stimulates the emission of the first R_- photon from the electron, forming a bright pair $|R_- R_-\rangle$. This pair departs in the same direction as the original pair. The emission of the bright pair returns the impulse $\Delta p = \eta P_{\mathrm{R}}$ to the electron, exactly cancelling the initial momentum transfer. After the complete cycle, the electron is at rest again. Over many such interactions in an isotropic sea of photon pairs (flat space), the transient momentum transfers average to zero. However, if the particle somehow finds itself in an anisotropic sea of primordial pairs (curved space), the net momentum transfer is no longer zero. Also, while continuously transforming 'dark' pairs into 'bright' pairs, the particle is radially altering the isotropic sea of primordial photons which curves space around it and its effect will be felt by other particles of mass.

A small fraction of incident flux is transformed to a different photon-pair mode, shown in [Figure 1], creating an asymmetry of (in/out) around the mass.

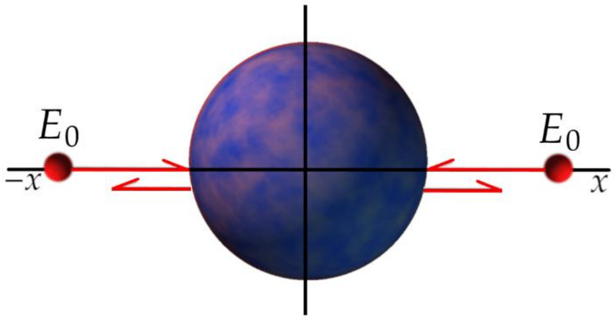

Figure 1: A mass remains at rest in a symmetric fluence rate.

However, a composite mass remains 'at rest' if the net fluence rate is symmetric. No net momentum is imposed on this mass due to its own asymmetry.

The pushgravity models of Fatio and Le Sage

Push-gravity has seen much opposition. First proposed by Fatio[1690] and followed by the attempts at publications by Le Sage [1748]. Other 'superfluid aether' or 'shadow-gravity' theories have not gained traction in mainstream physics[6-13]. Edwards' book[10] in 2002 revived significant interest into the study of the subject from which Barry Mingst and Paul Stowe[11], two of the original contributors to Edwards' book, have also recently presented a host of new arguments in favour of the existence of an aether and the workings of pushgravity.

Newtonian gravity [1687], with its 'Instant action at a distance' has been very powerful in describing the dynamics of motion, yet scenarios arose where its equations could not match observations. Newton was superseded by Einstein's General Relativity (GR) [1916][15,16]. Today one can intuitively imagine how curved space could create a path for matter to move, but still no explanation is offered for how matter bends space, and a mechanistic explanation for the workings of gravity still does not exist.

The problems with G

This work aims to resolve problems that exist in both Newtonian and Relativistic gravity models with a simple pushgravity model, that reveals G as only an apparent constant in our local field, while being an exponential non-constant in some extreme cosmic scenarios.

SI units of G[17] are ‘N.m^2/kg’, which reveals the inverse of what Newton’s equation does, but is otherwise unintuitive as to how gravity happens.

Measurements of G have not revealed the accuracy level required for other physics constants. A comprehensive review on measurements problems with G is presented by C. Rothleitner and S. Schlamminger[18,19], and also by Junfei Wu et al[20], and others[21,22].

In this document

We introduced a concept with some simple QED formalism. The remainder of this document will not be deriving a quantum gravity model, but is intended to bring across its argument with basic mathematic methods. We begin by presenting a pushgravity model of the dynamic aether, the isotropic radiant energy density, building on from the introduction, and defining some specific required parameters. Next, we derive Newtonian gravity from a photon-pair transformation model. We derive our final equation of G revealing a hidden exponential component, which immediately quantifies known anomalous gravitational effects. We analyse the anomalies in addendum A.

Strength of the primordial aether

Recalling equation (13) from Rueda and Haisch,

$$m_i = m_g = \frac{V_0}{c^2} \int \eta(\omega)\, \rho(\omega)\, d\omega \tag{2}$$

This is recognised as a form of m=E/c^2. We interpret V_0 as the volume of object interaction, and η(ω) as the probability of interaction, and ρ(ω) as the energy density of the zero-point fluctuations. Because our proposal is for fixed discrete energies of monochrome aether photon-pairs, neither η nor ρ of the flux are now a function(ω) and thus integration to a fixed frequency leaves ρ*ω as the radiant energy density per volume * frequency of the primordial photon pairs. We assign $E_v(I_0)$ as the total energy of the interacting primordial photon pairs from eq(1):

$$E\psi = \eta E_v(I_0) \tag{3}$$

We can deduct from eq(2) that for the mass energy:

$$m_i c^2 = V_0 \eta E_v(I_0) \tag{4}$$

Lorentz factor γ intentionally left out.

Acknowledging that the mass m_i interacts in the volume V_0, we can reduce the energy intensity per volume equation to:

$$E_v(I_0) = \frac{\rho_i}{\eta} c^2 \ in \ [\frac{J}{m^3}] \tag{5}$$

, where ρ_i is the mass density in the volume V_0. We know typical densities of composite and atomic matter (excluding electron degenerate matter for now) range from very dilute gases $0 < \rho \leq 22.59$ kg/m^3 for osmium, and we can conclude that since mass shielding is not a common and known phenomenon that the interaction factor must be of the order $\eta \ll 1$. The fraction η represents the portion of aether that couples with the 'volume' of the object which appears to be a variable in the equation, and we argue that the right side of eq(2) refers to an object's volume but has no reference to the object's density, only to fluence rate. We thus argue η is hiding the proportionality to the density of m_i, and since $E_v(I_0)$ is a constant in eq(5), and c^2 is a constant, we agree on ρ_i/η to be a vacuum constant. Then we can now set an expectation on the lower limit for the energy of primordial aether in a volume of 1m^3:

$$E(I_0) \gg \rho_i c^2 \ in \ [J] \tag{6}$$

In eq(7) we determine the flux of the primordial aether I_0 from eq(5) by dividing by the photon pair momentum (unknown) to get number of particles per m^2 per second, and we reference to A=1m^2 to get the flux in particles per second:

$$I_0 = \frac{\rho_i}{\eta} c^2 * \frac{\lambda}{h} \ in \ [\frac{\#}{s}] \tag{7}$$

Defining the flux and interactions with mass

For simplicity and clarity, we analyse the effects of an isotropic stochastic background of photon pairs in one dimension only, where we divide the isotropic radiant energy density onto any object under scrutiny into a +x (right) and -x (left) section and combine the total x-components, as shown in Figure 2.

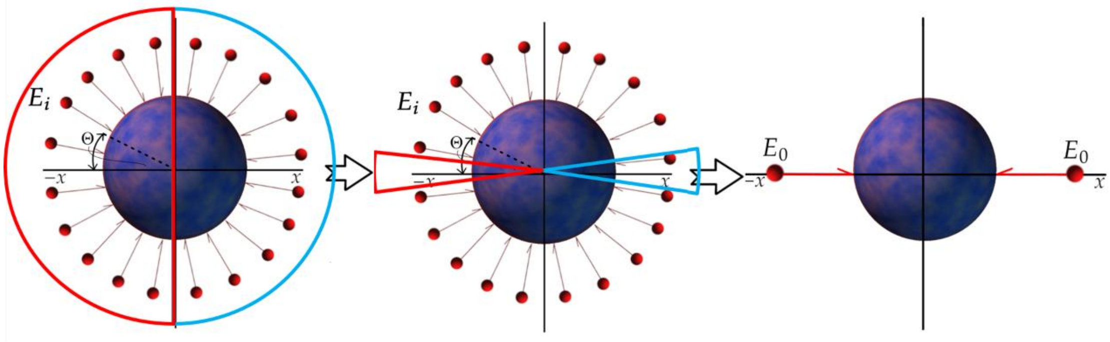

Figure 2: Consolidate all photon-pairs with ±X components into one unit of flux.

In flat space the total sum of the energy vectors E_{0xi} of all the photon pairs entering the object in a symmetric aether (flat space) will approach to zero.

$$\overrightarrow{E_0}\hat{x} = \sum_i \overrightarrow{E_r} * sin\theta_i * cos\varphi_i \hat{x} \simeq 0 \qquad (8)$$

By splitting vertically, the net fluence rate in [Figure 2], image on the right is presented as two single x-momentum non-zero boson composites approaching the object. The object does not gain any momentum from these bosons combined if conditions remain that flux $|E_{0(+x)}|= |E_{0(-x)}|$.

From the introduction we proposed that particles of mass transform 'dark' primordial photon pairs into 'bright' photon pairs, and that composite masses are largely transparent to the dark photon pairs. Transformation causes a reduction in primordial photon-counts in a linear path. Absorption of electromagnetic rays[23], through semi-transparent matter, as per example in [Figure 3], follows an exponential decay curve (Beer-Lambert law). We set our typical equation as eq(9):

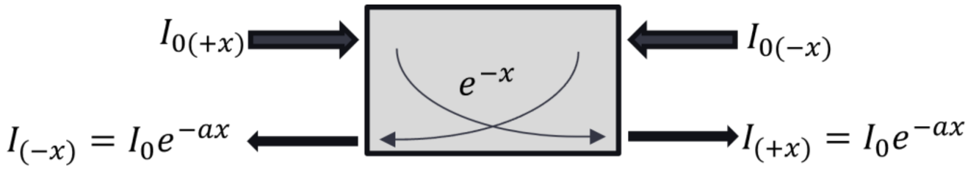

Figure 3: Typical electromagnetic absorption curve, with (+x) and (-x) decay shown.

$$I_{(\pm x)} = I_{0(\pm x)} * e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]} \; in \; [\frac{\#}{s}] \qquad (9)$$

where μ/ρ is the mass attenuation coefficient given in m^2/kg, and ρ is the density of the element (kg/m^3). The term 'X' is the length of the path. Units of $I_{(\pm x)}$ and $I_{0(\pm x)}$ are in particles per second.

Recalling from eq(8) that $|E_{0(+x)}|= |E_{0(-x)}|$, in a symmetric isotropic field, thus flux $|I_{0(+x)}|= |I_{0(-x)}|$. From any one side of the object in [Figure 3], we can define the transformed fraction I_a e.g.:

$$I_{a(x)} = I_{0(-x)} + I_{(+x)} \; in \; [\frac{\#}{s}] \qquad (10)$$

The net effect from eq(9), for one object, and without the vectors for further simplicity:

$$I_a = I_0\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right)\ in\ [\frac{\#}{s}] \tag{11}$$

Since I_a is the linear absorption of particles $\#/m^2/s$ over a distance 'x', absorption through a surface area 'A', will be the total net fluence rate into a volume; resultant $I_{a(vol)}$ can now be calculated:

$$I_{a(vol)} = I_0 A\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right)\ \ in\ [\frac{m^2}{s}] \tag{12}$$

A Maclaurin series expansion for $e^{-\mu\rho x}$, for any $\mu\rho x <<1$ gives a result to the first order,

$$e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]} = 1 - \left(\frac{\mu}{\rho}\right)\rho X \tag{13}$$

$$I_{a(vol)} = I_0 A\left(1 - \left(1 - \left(\frac{\mu}{\rho}\right)\rho X\right)\right) \tag{14}$$

$$I_{a(vol)} = \rho * X * A * \left(\frac{\mu}{\rho}\right) I_0\ \ in\ [\frac{m^2}{s}] \tag{15}$$

, which X*A equates to a volume of a cube, and where ρ is the average density of the object, hence it follows logically:

$$I_{a(vol)} = \left(\frac{\mu}{\rho}\right) I_0 * M\ in\ [\frac{m^2}{s}] \tag{16}$$

This exercise with a cube, can also be done for a sphere, with a similar result. We then substitute I_0 into eq(16) from eq(7):

$$I_{a(vol)} = \left(\frac{\mu}{\rho}\right) * \frac{\rho_i}{\eta} c^2 * \frac{\lambda}{h} * M\ \ in\ [\frac{m^2}{s}] \tag{17}$$

For the components in eq(17) we argue as follows: Measured fluctuations for known values of μ/ρ (for atomic material), at different frequencies, are due to photonic interactions (photoelectric effect, Compton scattering, pair production), which will not be active with neutral and dark photon-pairs, and for frequencies beyond x-rays μ/ρ narrows to a constant. We have already argued at eq(5) that ρ_i/η is a constant. Wavelength λ of the photon pairs are unknown but from our proposal of fixed-frequency photon-pairs this is taken as a constant. We set a new μ as consolidated coefficient, and we reference to $1m^2$:

$$\mu = \left(\frac{\mu}{\rho}\right) * \frac{\rho_i}{\eta} * \lambda\ in\ [m^2] \tag{18}$$

And substituting into and simplifying eq(17):

$$I_{a(A)} = \frac{\mu c^2}{h} * M \text{ in } [\frac{m^2}{s}] \quad (19)$$

To convert from particle density to flux-density we multiply by the speed of the photon ‘c’:

$$I_{a(\psi)} = \frac{\mu c^3}{h} * M \text{ in } [\frac{m^3}{s^2}] \quad (20)$$

Due to net inflow of the primordial dark pairs into the mass(M), and less outflow, an asymmetry of radiant energy density (in vs out) is formed around mass (M).

To predict the effect of this interaction over a distance, since the asymmetry is a vector field pointing in toward the (centre of) mass(M), we invoke a Gaussian sphere and define a point P, at distance (r) from the mass, to measure potential of the asymmetry at that point:

$$I_{a(\psi)(r)} = \frac{\mu c^3}{h} * M * \frac{1}{4\pi r^2} \; in \; [\frac{m}{s^2}] \quad (21)$$

Rewriting eq(21) for clarity:

$$g(r) = \frac{\mu c^3}{4\pi h} * \frac{M}{r^2} \; in \; [\frac{m}{s^2}] \quad (22)$$

, which we recognise as the Newtonian limit, with:

$$G = \frac{\mu c^3}{4\pi h} \; in \; [\frac{m^3}{kg.s^2}] \quad (23)$$

We can now extend this to two bodies, while remaining in the Newtonian limit.

From eq(22) and [Figure 4], but choosing spheres as interacting objects for calculations: Mass (M) creates an asymmetric field around itself due to flux absorption. The other mass (m) presents itself with a cross-section area ($A = \pi R^2$) through which the asymmetry around M will enact an asymmetric interaction in m, resulting in a push force of m toward M. [This describes one part of a two-body, or many-body, interaction only]

Fatio de Duillier in 1690, even though he did not know about atoms or radiation curves, argued that such an asymmetry could create a net force that pushes one object to another, which would then appear as if the objects are attracting each other, as shown in [Figure 4]:

Figure 4: A graphic representation of Fatio de Duillier's pushgravity

The equation for the mean free path through a sphere[24,25] is shown as:

$$L_{eff} = \frac{4R}{3} \tag{24}$$

The apparent force on the second spherical mass m is then due to a push inward, from the original asymmetry around M, taken from eq(22):

$$\begin{aligned} F_m &= g(r) * L_{eff(m)} * \rho_m \\ &= \frac{\mu c^3}{4\pi h} * \frac{M}{r^2} * \pi R_m^2 * \frac{4R_m}{3} * \rho_m \\ &= \frac{\mu c^3}{4\pi h} * \frac{Mm}{r^2} \end{aligned} \tag{25}$$

Which we recognise as the Newtonian force equation between two masses, $F=GMm/r^2$.

If we were to do this same calculation from the vantage point of the other mass, we get the same equation, with M and m reversed, thus having no apparent effect on the resultant equation. The two forces appear equal, although vector directions are reversed. We still acknowledge that velocity components have thus far been excluded.

In eq(23) we showed G as a function of photon-pair transformation, containing parameters that appear to be constants. We use the agreed value of G from NIST:

$$G = \frac{\mu c^3}{4\pi h} = 6.67 * 10^{-11} \left(\frac{m^3}{kg.s^2}\right) \tag{26}$$

, with known values of c and h, we can conclude that for our use in the Newtonian limit:

$$\mu = \frac{4\pi G h}{c^3} = 2.0626 * 10^{-68} (m^2) \tag{27}$$

, which came as a mild surprise, is also shown as:

$$\mu = \frac{4\pi G h}{c^3} = 8\pi^2 L_P^2 \ (m^2) \tag{28}$$

Where L_p is the Planck length. Looking back at the definition for μ in eq(18), it is now apparent that for the photon pairs, $\lambda = \lambda_P$.

Extended Newtonian equation including exponential decay

We revisit eq(12), restated here for clarity:

$$I_{a(vol)} = I_0 A \left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right) \tag{29}$$

Which we now rework without simplifying the exponential, and multiplying by 1:

$$I_{a(vol)} = I_0 A\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right) * \frac{\left(\frac{\mu}{\rho}\right)\rho X}{\left(\frac{\mu}{\rho}\right)\rho X} \tag{30}$$

And rewriting to:

$$I_{a(vol)} = \frac{\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right)}{\left(\frac{\mu}{\rho}\right)\rho X} * I_0\left(\frac{\mu}{\rho}\right)\rho X A \tag{31}$$

We recognise the right-hand part of this equation from eq(15), and we thus repeat the steps of the previous derivation, this time without use of the Maclaurin simplification, to this concluded equation:

$$G = \frac{\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right)}{\left(\frac{\mu}{\rho}\right)\rho X} * \frac{\mu c^3}{4\pi h} \ in \ [\frac{m^3}{kg\ s^2}] \tag{32}$$

Of which the right-hand side is the same as eq(23) (Newtonian constant) and we label the left-hand side as the anomaly factor Z_x:

$$Z_X = \frac{\left(1 - e^{\left[-\left(\frac{\mu}{\rho}\right)\rho X\right]}\right)}{\left(\frac{\mu}{\rho}\right)\rho X} \ in \ [unitless] \tag{33}$$

Analysing eq(33): The variables (μ/ρ)ρX include the original μ/ρ as absorption coefficient, ρ for material density (typically related to μ/ρ) and X being the linear path of decay (e.g. diameter of earth, sol, football, etc).

Whereas eq(23) showed G as a constant in the conventional limit, we now have an equation for G which contains variables. For (μ/ρ)ρX<<1 the value of Z_x~1 and G appears to be a constant, but only if the condition remains satisfied. This condition is the Newtonian limit. The analyses of Z_x are shown in Addendum A, revealing some known anomalous gravitational effects when the condition is exceeded.

Discussion

Equation (6) shows that the radiant energy density is expected to be a large mismatch for the extreme low value of Lambda Λ in Standard Cosmology, providing a path to falsification.

It should be noted from eq(23) that the effects of gravity were first derived with one mass only, where any small object 'm', approaching mass 'M', will then be accelerated at 'g', independent of that small body's mass. Here we have shown pushgravity without a 'shadow' between two masses. If anything, 'g' is the self-shadow of the primordial flux around the mass M.

We have revealed an 'independent-from-G' link to the Planck Length L_p through the new μ of eq(18) and eq(27) albeit still loaded with new unknowns. If we naively substitute λ with the Planck length in eq(7) we rewrite the flux density in eq(34), which affirms the mass relation to the Unruh effect, as initially proposed by Rueda and Haisch in their work, now related to a monochromatic ZPF:

$$I_0 = \frac{\rho_i c}{2\pi\eta} * \sqrt{\frac{G}{\hbar c}}\ in\ [\frac{\#}{s}] \tag{34}$$

And we can simply rewrite eq(5) to reveal the vacuum interaction with mass into a new eq(35) as a fractional interaction with Planck photon(s), and from η<<1 can conclude this is likely a result of a spin-spin collision of primordial pairs with the particle, with m/η now a confirmed constant factor, as first stated at eq(5):

$$m_i c^2 = \eta_i \hbar\omega_P \tag{35}$$

, and with η now revealed for fundamental particles (electron, muon, etc.) as a ratio of Planck length to particle's reduced Compton wavelength:

$$\eta_i = \frac{\lambda_p}{\bar{\bar{\lambda}}_i} \tag{36}$$

, and since $\lambda_p << \lambda_c$ for all known fundamental particles, then $\eta_i << 1$ is now also confirmed.

The inclusion of the 2-body equation followed from the one-body derivation. It also becomes evident now that Newton's equations are an approximation for 'low' values of G*M, since the term $e^{-\mu\rho x}$ from eq(9) does not reappear in the equations above but remains simplified. It is also shown that this isotropic irradiance absorption/transformation model is based on 'standard' molecular masses and that the model varies greatly for 'degenerate' masses e.g. neutron stars or black holes, and for large distances such as galactic disks or the observable universe.

It was shown that G is a function of aether interaction with mass, which we have now derived as Z_x*G. In extreme cosmic conflicts the Newtonian law of F1=F2 would no longer hold if $Z_{x1} \neq Z_{x2}$, as may be an example of the sun vs Mercury.

Here, a note may be inserted to explain the apparent 'instant action at a distance' which is an apparent effect from Newton's equation. While the effects of gravity may be compared with the effects of a static field, it has already been established that changes in gravity move at the speed of light, which this document agrees with, yet Newton's equations (with a raw G) did not seem to rely on the speed of light. It is as if the mass and its surrounding 'static' field already 'knows' where the other mass is. We have presented a G that includes actions that happen at c, which is now more intuitive. Understanding the asymmetry created by the transformation of primordial flux, at the speed of light, takes the mysticism out of this effect. A mass can establish an asymmetric flux field over time 't' and distance 'ct' without the nearby presence of another mass. When other masses approach, it only appears as if there is an instant gravity between the objects. This is because the masses are moving into each other's asymmetric field, *which is already there*, and updated radially outward from the mass at 'c'. Even where gravitational aberration is expected, where the masses have a relative velocity to each other, it has been shown that aberration is cancelled by velocity components[24,25].

Conclusion

Our main conclusions of this paper must be that we have a convincing argument that Fatio and Le Sage's pushgravity is real, and an isotropic radiant energy density, a dynamic aether, at Planck scale, must therefore exist. We derived an equation for G, the gravitational 'constant', from first principles, which now includes fundamental constants, and within a basic mathematical framework provides immediate solutions to currently known cosmic anomalies such as Sun vs. Mercury, galactic rotation curves, black holes, and the event horizon problem of the observable universe. Replacing G in General Relativity or other unmodified relativistic models with Z_x*G must yield similar results without additions of Dark Matter or Dark Energy. Notwithstanding the above explanation, it is acknowledged that a relativistic gravity model is still essential.

The derivation of G shows it to be related to the Planck length.

It is now evident that Z_x*G is not an absolute constant, with variances in extreme cosmic scenarios understood.

The solution opens the way toward finding a full quantised solution for gravity and encourages further research into the workings of the aether.

A conceptual analysis has been presented in motivation for space as the ZPF of Rueda and Haisch, and mass being related to the Unruh effect. The discrete energies of the correlated photon-pairs of Grahn, Annila and Kolehmainen, to which matter is mostly transparent, allowed derivation of the intricacies of gravity. The final objections to Fatio/Le Sage's theories of pushgravity have now been overcome.

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The author declares that this manuscript represents the definitive, submitted for peer-review, presentation of this research. Other preliminary, non-peer-reviewed, or incomplete versions of this paper should not be considered.

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Addendum

A. Gravitational and cosmic anomalies, a brief sketch

Recalling Z_x from eq(33), the units of μ/ρ [m^2/kg], ρ [kg/m^3], X [m], all cancel out, and the component Z_x is unitless. We know in the Newtonian limit Z_x~1 from the constraint in the exponential term that μ/ρ*ρ*X<<1. Values of both ρ and X~R are known for various celestial masses, and since we are not considering subatomic particles here, we can for these analyses see that ρ*x >>0. The component μ/ρ, for absorption/transformation of primordial isotropic radiation, is unknown though. The condition μ/ρ*ρ*x <<1 (since mass shielding and gravitational shielding is not an easily observed effect) means that μ/ρ<<1. However, choosing a μ/ρ to satisfy this condition remains subjective.

To find a compatible value for μ/ρ for 'normal' atomic matter, we use earth density and radius and find a compatible μ/ρ=10^{-12}, also meeting the two conditions:

- Z_x must be ~0.999.. to at least the 5th decimal. (Since G appears to be accurate to only 5-6 decimals)
- The graph functions must represent a visual understanding of cosmic phenomena.

Graphs were generated on Desmos.com. Data μ/ρ, ρ, and X used for each curve is shown in the graphic. Charts were edited to cut off at ±R. Example for earth:
https://www.desmos.com/calculator/js0rrrcjqo

For various examples of ρ and x we then attempt to explain observed cosmic anomalies. Separated here to graphically show results of concept, not to attempt a precise match of known data. The graphs are scaled on the x-axis to show the ±radius of the object under scrutiny, and object centre at 0. Y-axis scaled from 0-1 show expected variations in G.

For each analysis below, the equations on the charts were manipulated from Z_x to show exponential decay from 'left=-R' in BLUE and 'right=+R' in GREEN. Net strength of gravity at any point would be the difference between the ±curves, and is shown in RED. Only for galactic disks is a third chart shown from calculating orbital velocity.

For 'galactic disk' and 'universe' we had to choose a ρ that didn't 'break' the graph but still revealed the results of the study.

Neutron star and Black Hole, with ρ~10^{17} does not qualify as 'normal atomic matter'. Here we chose μ/ρ=$10^{-20.5}$, to attempt matching cosmic observations.

Earth-sized masses and smaller where ρ typical ~5000 kg/m^3 and x ~10^6 m

In this weak limit, for μρx << 1, eq(33) reduces to ~1 and gravity appears Newtonian. As expected, it appears very linear from -R to +R.

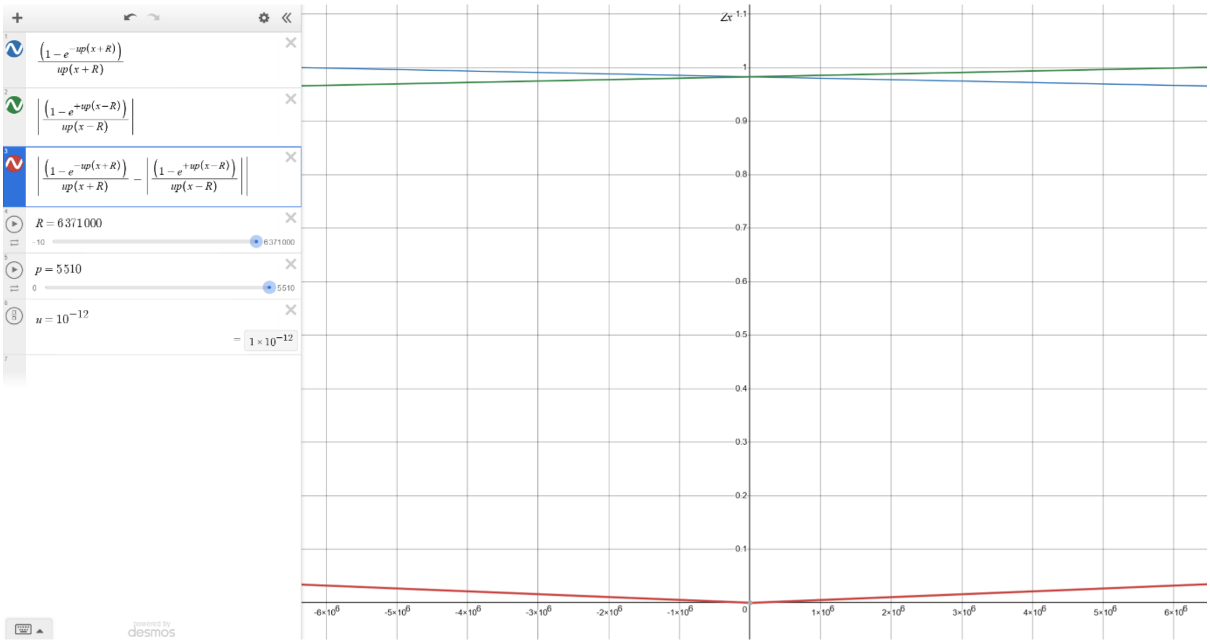

Figure 5: Earth absorption (blue and green) and net effext of Z_x (red) curves.

Sun sized masses with ρ typical ~1400 kg/m^3 and x ~10^9 m

Exponential decay is noticeable. Enough to show a gravitational anomaly might exist between e.g. Sol vs Mercury.

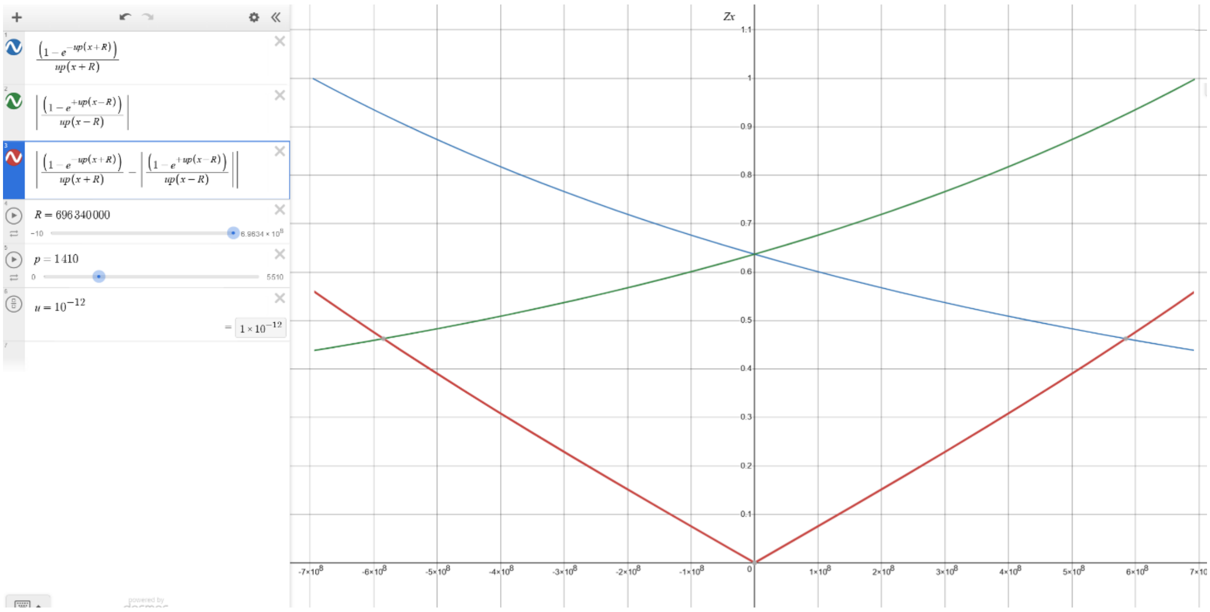

Figure 6: Sun absorption (blue and green) and net effext of Z_x (red) curves.

Neutron star: For very large ρ~10^{17} kg/m^3 such as neutron-degenerate matter with smaller than sol diameter x~10^4 m the exponential becomes markedly noticeable (but not reaching close to zero within this limit of x). We used $\mu = 10^{-20.5}$.

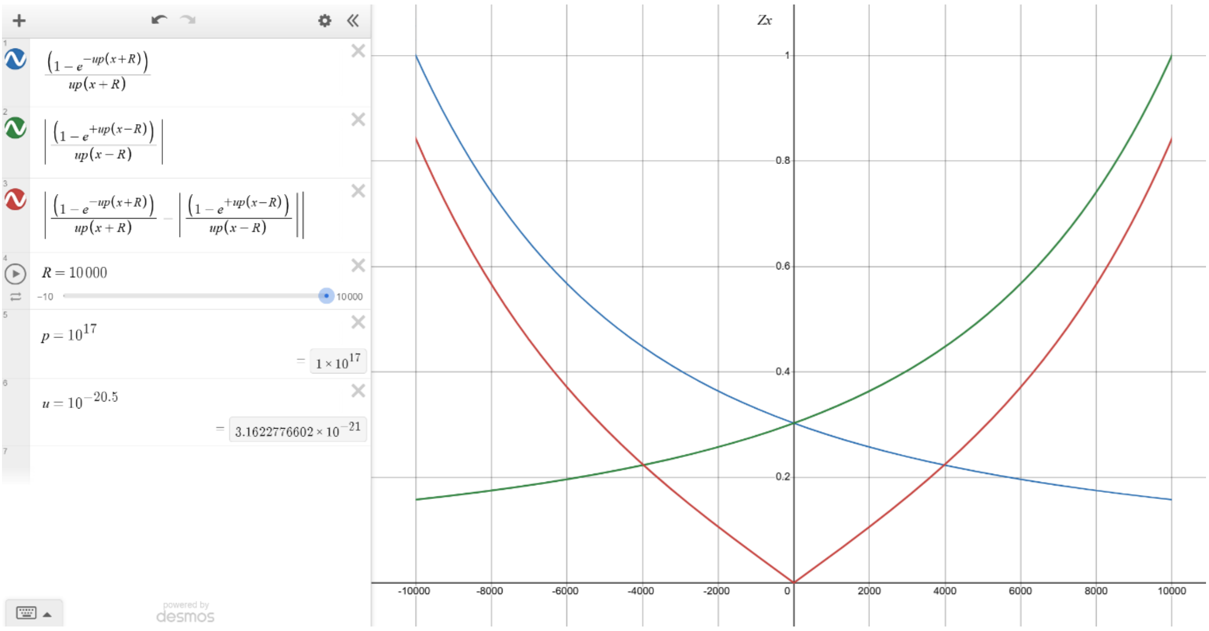

Figure 7: Neutron star absorption (blue and green) and net effext of Z_x (red) curves.

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Black hole: An extension of the neutron star example, ρ~ 10^{17} kg/m^3 for a small x~ $3*10^4$ m dark star. Aether transparency is severely reduced since most or all of the inflowing primordial aether is transformed in transit through the mass. We chose the same as for neutron star, u=$10^{-20.5}$ to show opacity is approaching maximum. Note that for the combined (red) graph the line crosses unity at the radius, where-as for other objects analysed so far it extended to left and right. Crossing at R for the net effect seems to then indicate maximum opacity, with the absorption curves (blue and green) approaching zero at the exit side.

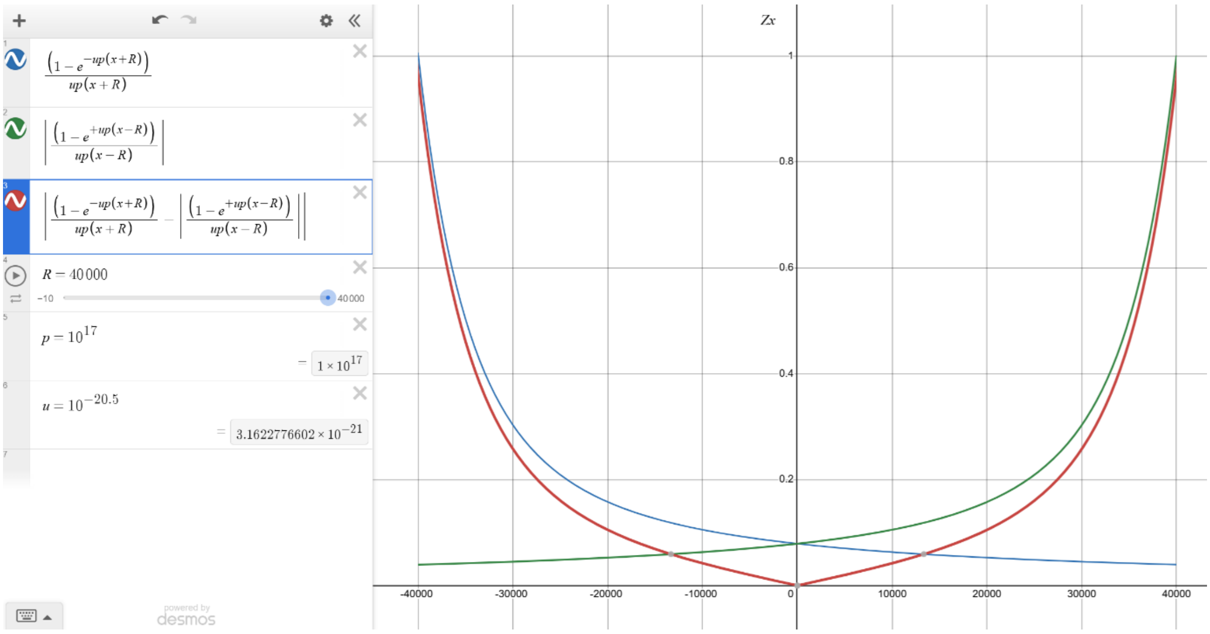

Figure 8: Black Hole absorption (blue and green) and net effext of Z_x (red) curves.

Galactic Disk: For a small ρ<<1 e.g. galactic disk, and ρ itself decreasing exponentially with respect to r from the centre, and a large x~10^{17} m for the disk.

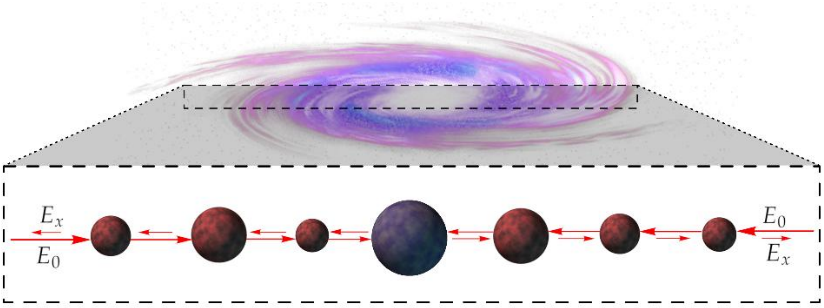

Figure 9: Representation of flux dilution in a spiral galaxy disk, viewed side-on into the plane of the disk, shows diminishing flux from each side until out the other side.

Since the disk is diffused but concentrated in a narrow 'disk', it is apparent that additional ±x.(cosθ) aether components must contribute from above and below the disk, and the disk radiation density cannot be diluted to 'zero' as with the black hole. If there were no ±x components induced, no outward push would remain, and the disk would summarily collapse into the central mass. However, inward gravity is higher than expected, as is known from velocity curves.

The chart below done naively with ρ constant through the disk.

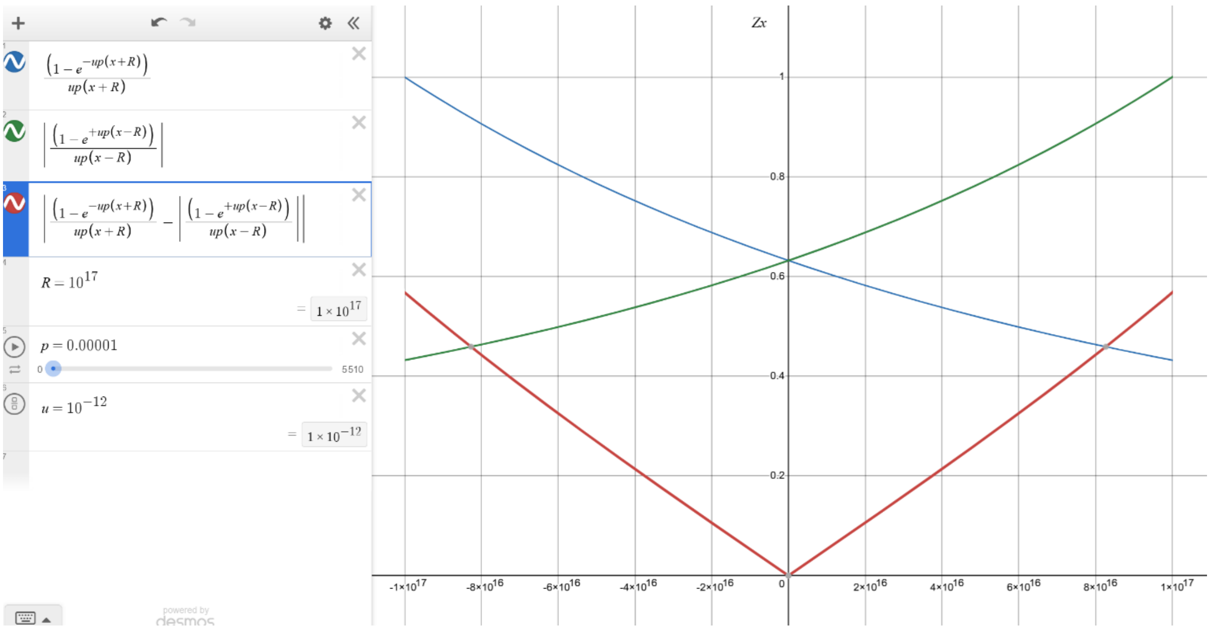

Figure 10: Galactic disk absorption (blue and green) and net effext of Z_x (red) curves.

Substituting ρ with an exponential decay over the radius of the disk, the net effect (red) changes as shown in Figure 11. From a naive $v^2 = GM/r$ we show the square root of the net effect (black) as an indication of the expected velocity curve. M/r still need to be included, where M would be the total mass content within x, but M/r was approximated here as a constant value over the length of the disk. Influence of the central mass object has not been included, and this solution was applied with $DM_{HALO}=0$.

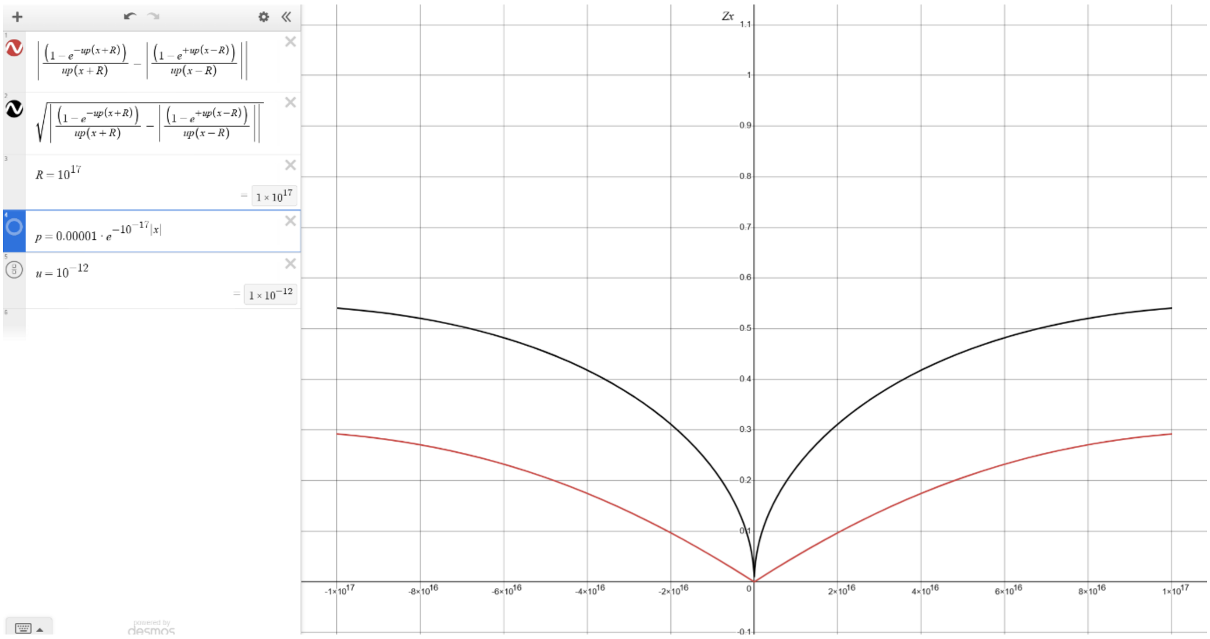

Figure 11: Galactic disk net absorption (red) and velocity (black) curves, accounting for exponentially declining mass as a function of radius. Central mass not included.

Cosmologic scale: Here ρ<<<1 even much smaller than the galactic disk but for a distance x~ 10^{27} m gives a noticeable reduction of the flux, showing that the extreme distance would become opaque, similar to a black hole viewed from outside. We conclude what is observed as a weakening of the background of primordial photons, is mistaken as a velocity component of the observed distant object. Far-away observations are pronounced, 'redshifted' as if they are near the edge of a black hole, compared to (relatively) nearby.

In the galactic disk scenario, we made the conclusion that additional ±x.(cosθ) aether components must contribute from above and below the disk else the disk would collapse toward the central mass. A similar question arises here: In the extreme limit you see 'nothing' while locally all appears in order. If there is 'little to no' aether remaining locally from the edge of the universe, how is there still gravity here? Which leads us to the conclusion that primordial photon pairs must be replenished from within the universe.

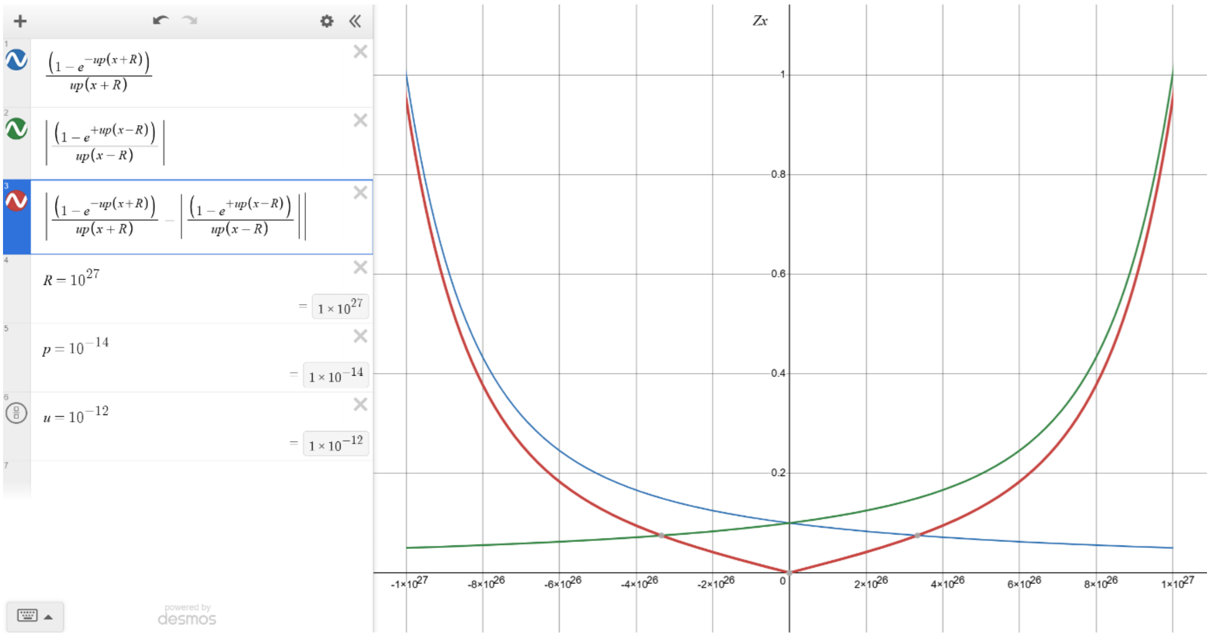

Figure 12: Absorption absorption (blue and green) and net effext of Z_x (red) curves.