An Introduction to the Theory of Everything Using Energy Gradients and Information Horizons

Bhatt, Ankur S.   Becker, F.M.

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Abstract

The quest to unify the four fundamental forces has been sought after for decades but has remained elusive to all physicists. The first clues to unification were given when information horizons were associated to radiation by Unruh and Hawking. This was then extended to be a discrete spectrum in nature by McCulloch. Here, it is suggested that the limitation, or confinement, of an allowed spectrum is relevant in order to compute all the fundamental forces. The maximum spectrum is defined by the size of the cosmic particle horizon and the Planck length. Notably, all fundamental forces can be computed by using the same core equation and can be extended to reflect the different information horizons and particle interaction scenarios. This result suggests that for unification the radiation spectrum provides alterations of the momentum space to generate energy gradients. The force derivatives of the energy fields indicate numerical convergence to the observed fundamental forces.

1 Introduction

Over the last several decades standard physics have been expanded with new hypotheses that indicate information horizons are associated with radiation [2] [15] [16] [7]. The initial theories by Hawking, Davies and Unruh dealt with the emission of thermal radiation from information boundaries. More recently, this has been complimented by McCulloch suggesting that only radiation between horizons are allowed using nodes at the horizon confinement [11] [10]. This discrete spectrum of radiation is limited on a cosmic scale by the particle horizon, Θ, for the longest allowed wavelengths and the Planck length for the smallest. The energy and momentum of such a spectrum would be the superposition of all energy and momentum eigenstates (frequency modes of the waves). This superposition suggests a maximum allowed energy however a blockage occurs which provides a causal barrier affecting the symmetry. Therefore, a modified inhomogeneity of the allowed momentum modes in realm of the virtual particles zones with different maximum allowed energy and momentum becomes established. This breaking of symmetry in the zero point field (ZPF) leads to energy gradients which result in forces due to the law of conservation of momentum. The forces are computed by the mathematical derivative of the energy fields; an approach outlined by quantum field theories. All four fundamental forces have been tested for conformity with available observations in trend and value. This paper demonstrates that for all fundamental forces, the core equation is identical.

2 Method

2.1 Electromagnetic Force

Consider the wave energy of a virtual photon between two charges.

$$E = \frac{hc}{\lambda} \tag{1}$$

Plug in for $\lambda = (k+1)l_p$ in order to count all the waves in the confinement region up to N between the charges. Note all waves are counted up to the fundamental wavelength where $k = 1$ and $2l_p$ is the Schwarzschild radius for Planck length energy [14].

$$\sum_{k=1}^{N} E_d = \frac{hc}{2l_p} + \frac{hc}{3l_p} + \cdots + \frac{hc}{Nl_p} \tag{2}$$

Plug in for $\lambda = (k+1)l_p$ in order to count all the waves in the observable universe M.

$$\sum_{k=1}^{N} E_R = \frac{hc}{2l_p} + \frac{hc}{3l_p} + \cdots + \frac{hc}{Ml_p} \tag{3}$$

Now take the ratio of of the following.

$$\frac{E_R - E_d}{E_R} = \frac{\sum_{k=1}^{M} \frac{1}{k} - \sum_{k=1}^{N} \frac{1}{k}}{\sum_{k=1}^{M} \frac{1}{k}} \tag{4}$$

Use the closed form approximation for a harmonic series formula namely $\sum_{k=1}^{J} \frac{1}{k} = \ln(Je^{\gamma})$ where Euler–Mascheroni's constant is denoted as γ. This approximation becomes an equality when M and N are large as the higher order terms will drop out.

$$K = \frac{\ln(Me^{\gamma}) - \ln(Ne^{\gamma})}{\ln(Me^{\gamma})} \tag{5}$$

Notice the numerator can be seen as a subtraction of action elements. These elements represent the integral under the energy/momentum accumulation curve.

The momentum of a virtual photon can be defined as $p = h/\lambda$ and this factor is then multiplied by the logarithmic division ratio which represents an integral over the superposition of momentum eigenstates from the lower to upper limit of the involved spectrum distance. The logarithmic portions of the formulas could be considered a measure of the involved momentum. Notice the e^γ cancel out due to logarithmic properties.

$$K = \frac{\ln(M) - \ln(N)}{\ln(Me^\gamma)} \tag{6}$$

Simplify by combining the logarithms to have a more succint form.

$$K = \frac{\ln(M/N)}{\ln(Me^\gamma)} \tag{7}$$

Now plug in for $M = \frac{\Theta}{2l_p}$ and N$= \frac{x}{2l_p}$ where $\Theta = 8.8 \cdot 10^{26}$ m.

$$K = \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta}{2l_p})} \tag{8}$$

Follow the same procedure as above but divide the waves in between the two elements over the total waves of the observable universe. This physically is the effective pressure between the objects that works in the opposite direction of the push, K, from the outside. The effective action ratio for each fundamental force will be the following.

$$Sr = \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{9}$$

Now compute the fundamental energy around the two unitary charges at a distance x. This is done by multiplying the fractional waves by $\frac{\alpha hc}{x}$ where $\lambda = x$. Multiply by $\frac{4}{2\pi}$ as the discovered constant factor in front. Finally multiply by $K \cdot Sr$.

$$E_{em0} = \frac{4\alpha hc}{2\pi x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{10}$$

Now assume the two objects are composed of a certain amount of charges namely q_1 and q_2.

$$E_{em} = \sum_{i=1}^{q_1} \sum_{j=1}^{q_2} E_{em0} \tag{11}$$

This reduces down to the following.

$$E_{em} = q_1 q_2 E_{em0} \tag{12}$$

Rewrite in terms of Planck charge particles. Replace $q_1 = N_{p1}\alpha\sqrt{4\epsilon_0\hbar c}$ and $q_2 = N_{p2}\alpha\sqrt{4\epsilon_0\hbar c}$ where N_{p1} and N_{p2} are number of Planck charges and substitute in for E_{em0}.

$$E_{em} = \frac{4\alpha hcN_{p1}\sqrt{4\pi\epsilon_0\hbar c}N_{p2}\sqrt{4\pi\epsilon_0\hbar c}\alpha}{2\pi x}\frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})}\frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{13}$$

This can be rewritten as the following using Planck charges to show where the factor of $\frac{4}{2\pi}$ comes from.

$$E_{em} = \frac{\alpha^2 hcN_{p1}N_{p2}\sqrt{8\epsilon_0\hbar c}\sqrt{8\epsilon_0\hbar c}}{x}\frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})}\frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{14}$$

Now that the variations of energy forms have been addressed, continue from (10) and reduce the equation.

$$E_{em} = \frac{2\alpha hcq_1q_2}{\pi x}\frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})}\frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{15}$$

The definition of the derivative of the following type of equation is the following.

$$\frac{d}{dx}\left(\frac{A\ln(B/x)\ln(Cx)}{x}\right) = A\left(\frac{\ln(B/x)(\ln(Cx)-1)+\ln(Cx)}{x^2}\right) \tag{16}$$

Take the derivative of the energy equation and take the absolute value to find the force magnitude.

$$F = A\left|\frac{\ln(B/x)(\ln(Cx)-1)+\ln(Cx)}{x^2}\right| \tag{17}$$

Where, $$A = \frac{2\alpha hcq_1q_2}{\pi\ln^2(\frac{\Theta e^\gamma}{2l_p})}, \quad B = \Theta, \quad C = \frac{e^\gamma}{2l_p}$$

2.2 Weak force

The unification between the electromagnetic force and weak force have been accomplished under Electroweak theory. In order to unite the two forces use the revised EM formula from section 2.1 and simply add the exponential decay factor as noted by the Yukawa potential namely, $Y = E_{em}e^{\frac{-m_w xc}{\hbar}}$, where m_w is the mass of the W-Boson particle, x is the distance and E_{em} comes from

(10) [17] [3]. Note the coefficient in front of $\frac{4}{2\pi}$ will not be added since it is a one-directional emission of the boson and the interaction is a straight path.

$$E = \frac{\alpha hc}{x}\left(\frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta}{2l_p})}\frac{\ln\left(\frac{xe^{\gamma}}{2l_p}\right)}{\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right)}\right)e^{\frac{-m_w xc}{\hbar}} \tag{18}$$

Finally compute the derivative of the energy equation to find the force

$$\frac{d}{dx}\left(\frac{A\ln(B/x)\ln(Cx)e^{Dx}}{x}\right) = Ae^{Dx}\left(\frac{\ln(B/x)((Dx-1)\ln(Cx)+1)-\ln(Cx)}{x^2}\right) \tag{19}$$

Finally take the derivative of the energy equation to obtain the force equation. The sign of the equation will be a negative value indicating an attraction.

$$F = A\left(\frac{\ln(B/x)(\ln(Cx)-1)+\ln(Cx)}{x^2}\right) \tag{20}$$

Where, $\quad A = \frac{\alpha hc}{\ln^2\left(\frac{\Theta e^{\gamma}}{2l_p}\right)},\quad B = \Theta,\quad C = \frac{e^{\gamma}}{2l_p}\ D = e^{\frac{-m_w xc}{\hbar}}$

2.3 Strong Force

For the strong force there is an overlap of the two nucleons so the electromagnetic effect becomes negligible. Take the ratio of all the waves right when the strong force begins. This typically occurs around some x. This is slightly more than the diameter of a proton. Recall that the reduced Compton wavelength of a proton is $\lambda_{rc} = 1.3214 \cdot 10^{-15}$ [m] so this seems to fit the experimental data where double this value is where the force begins. Also the non-reduced Compton wavelength associated to the radius of the proton is $\lambda_c = 2.1031 \cdot 10^{-16}$ so we assume this is a key point where no more waves are allowed. Start with the action ratio form below.

$$K = \frac{\ln(Me^{\gamma}) - \ln(Ne^{\gamma})}{\ln(Je^{\gamma}) - \ln(Ne^{\gamma})} \tag{21}$$

Now compute the total amount of waves in the confinement region. First compute the total distance that will be traveled in the overlap region denoted by x and divide by the Compton wavelength, λ_c. For the numerator we subtract the hardcore region which is about double λ_c and divide by λ_c to obtain $\frac{x-2\lambda_c}{\lambda_c}$. Finally compute K.

$$K = \frac{\ln\left(\frac{x-2\lambda_c}{\lambda_c}\right)}{\ln\left(\frac{x}{\lambda_c}\right)} \tag{22}$$

The effective action ratio for each fundamental force will be the following as seen previously.

$$Sr = \frac{\ln\left(\frac{xe^{\gamma}}{2l_p}\right)}{\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right)} \tag{23}$$

Finally compute the Yukawa potential. Here, m_π is the neutral pion mass as it is the mediating particle. Notice the range is $r_0 = \frac{\hbar}{2mc}$.

$$Y = e^{\frac{-2m_\pi xc}{\hbar}} \tag{24}$$

Multiply all three components, $KSrY$ to the fundamental energy $\frac{2hc}{x}$ to find the total energy in the region. Notice the factor of 2 in the numerator may suggest a two way exchange of pions.

$$E = \frac{2hc}{x} \frac{\ln\left(\frac{x-2\lambda_c}{\lambda_c}\right)}{\ln\left(\frac{x}{\lambda_c}\right)} \frac{\ln\left(\frac{xe^{\gamma}}{2l_p}\right)}{\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right)} e^{\frac{-2m_\pi xc}{\hbar}} \tag{25}$$

Finally compute the force by taking the derivative of the energy equation. The sign of the equation will be a negative value indicating an attraction.

$$\begin{aligned} F = \frac{Ae^{Ex}}{x^2(x-C)\ln^2(Bx)} \Big(& \ln(Bx)(\ln(Dx)(x-(C-x)(Ex-1)\ln(B(x-C)))+ \\ & (x-C)\ln(B(x-C))) + (C-x)\ln(Dx)\ln(B(x-C))\Big) \end{aligned} \tag{26}$$

Where the constants are the following.

$$A = \frac{2hc}{x}\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right), \quad B = \frac{1}{\lambda_c}, \quad C = 2\lambda_c, \quad D = \ln\left(\frac{e^{\gamma}}{2l_p}\right), \quad E = e^{\frac{-2m_\pi xc}{\hbar}}$$

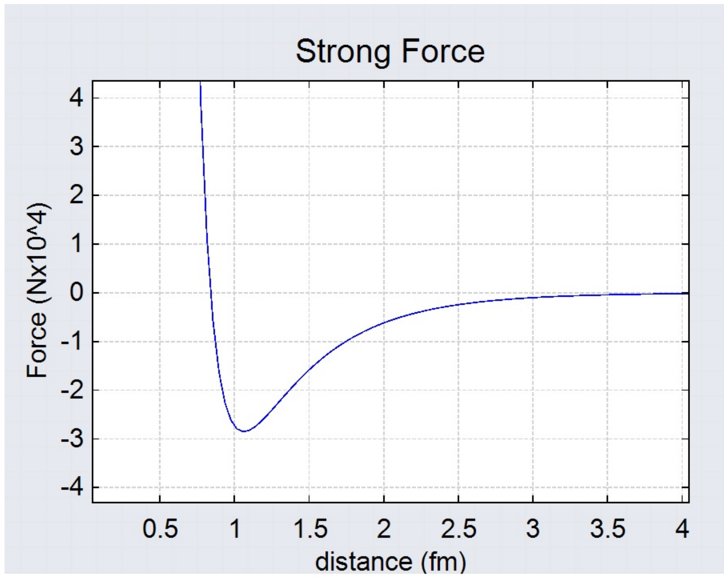

Figure 1: Strong Force versus Distance [8]

2.4 Gravitational Force

First compute the fundamental energy around the two Planck masses at a distance x. This is done by multiplying the fractional waves by $\frac{hc}{x}$ where $\lambda = x$. Multiply by $\frac{4}{2\pi}$ as in section 2.1 and finally multiply and by $K \cdot Sr$.

$$E_{G0} = \frac{4hc}{2\pi x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^{\gamma}}{2l_p})} \frac{\ln\left(\frac{xe^{\gamma}}{2l_p}\right)}{\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right)} \tag{27}$$

Now assume the two objects are composed of a certain amount of Planck masses namely N_1 and N_2. Each Planck mass number is associated with a virtual particle and their combinations of interactions of pairs of masses will result in a double summation [9].

$$E_G = \sum_{i=1}^{N_1} \sum_{j=1}^{N_2} E_{em0} \tag{28}$$

Compute both summations and simplify to obtain the following.

$$E_G = \frac{4\hbar c N_1 N_2}{x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^{\gamma}}{2l_p})} \frac{\ln\left(\frac{xe^{\gamma}}{2l_p}\right)}{\ln\left(\frac{\Theta e^{\gamma}}{2l_p}\right)} \tag{29}$$

Now, rewrite the number of Planck masses as $N_1 = m_1/m_p$ and $N_2 = m_2/m_p$.

$$E_G = \frac{4\hbar c m_1 m_2}{m_p^2 x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{30}$$

Next substutite in for $m_p^2 = \hbar c/G$ to obtain the following.

$$E_G = \frac{4Gm_1 m_2}{x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{31}$$

Next replace G where $G = \frac{l_p^2 c^3}{\hbar}$ [12] [6].

$$E_G = \frac{4l_p^2 c^3 m_1 m_2}{\hbar x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{32}$$

Notice that the minimum distance being used is the Schwarzschild radius so therefore the factor of 4 comes from the numerator where $(2l_p)^2 = 4l_p^2$. This gives a physical description to the value of the 4.

$$E_G = \frac{(2l_p)^2 c^3 m_1 m_2}{\hbar x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{33}$$

Using (29) one can also write the energy equation using the fundamental neutrino mass where $G_{cmb} = \frac{\hbar c}{m_{cmb}^2} \cdot \frac{\beta \pi^2 l_p}{4\Theta}$ and $m_{cmb} = 2.0792 \cdot 10^{-39}$ kg [1] [4] .

$$E_G = \frac{4m_1 m_2}{x} \frac{\hbar c}{m_{cmb}^2} \cdot \frac{\beta \pi^2 l_p}{4\Theta} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{34}$$

Additionally using (30) the energy equation can be written in term of the reduced Compton wavelength where $m = \frac{\hbar}{\lambda_c c}$.

$$E_G = \frac{4l_p^2 c^3 \hbar^2}{c^2 \lambda_{c1} \lambda_{c2} \hbar x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{35}$$

This reduces down to the following.

$$E_G = \frac{4l_p^2 \hbar c}{\lambda_{c1} \lambda_{c2} x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{36}$$

If the normal Compton wavelength is used instead of the reduced Compton wavelength namely $\lambda_1 = 2\pi \lambda_{c1}$ the energy equation will look like the following.

$$E_G = \frac{8\pi l_p^2 h c}{\lambda_1 \lambda_2 x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln\left(\frac{xe^\gamma}{2l_p}\right)}{\ln\left(\frac{\Theta e^\gamma}{2l_p}\right)} \tag{37}$$

This can also be written as the following replacing h with $\hbar$ indicating the circumference of a Schwarzschild circle.

$$E_G = \frac{(4\pi l_p)^2 \hbar c}{\lambda_1 \lambda_2 x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{38}$$

Writing the energy equation in terms of Einstein's constant can also be done. Multiply the denominator and numerator by c^4.

$$E_G = \frac{8\pi l_p^2 hc^5}{c^4 \lambda_1 \lambda_2 x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{39}$$

Multiply numerator and denominator by $\hbar$. Replace terms with $G = \frac{l_p^2 c^3}{\hbar}$.

$$E_G = \frac{8\pi}{c^4} \frac{G\hbar chc}{\lambda_1 \lambda_2 x} \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{40}$$

Finally rewrite in terms of Einstein's constant namely $\kappa = \frac{8\pi G}{c^4}$.

$$E_G = \kappa \frac{1}{\lambda_1 \lambda_2 x} hc \frac{\ln(\frac{\Theta}{x})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \hbar c \frac{\ln(\frac{xe^\gamma}{2l_p})}{\ln(\frac{\Theta e^\gamma}{2l_p})} \tag{41}$$

Now that the different variations of the energy have been addressed simply follow the same procedure in section 2.1 and apply the derivative to (37). The sign of the equation will be a negative value indicating an attraction.

$$F_G = A \left(\frac{\ln(B/x)(\ln(Cx) - 1) + \ln(Cx)}{x^2} \right) \tag{42}$$

Where, $\quad A = \frac{8\pi l_p^2}{\lambda_1 \lambda_2 \ln^2(\frac{\Theta e^\gamma}{2l_p})}, \quad B = \Theta, \quad C = \frac{e^\gamma}{2l_p}$

3 Discussion

One general source of error could arise from using either the Schwarzschild radius or the Planck length as the fundamental distance. Additionally, it could be possible that the one or both action ratios have a lower limit of a Schwarzschild circle circumference. Also, the exact topology of all the different fundamental forces are not exactly known and this would have a minor change to the convergence as well. For both the electromagnetic and gravitational forces, the overall deviation from Newton's Gravity Law and Coulomb's Law is within a few percent for each. The weak force is in the same range as Coulomb's Law at 10^{-18} [m] and falls off to approximately 10,000 times weaker at about $3 \cdot 10^{-17}$ [m] [5]. Finally, for the strong force, the overall shape is very similar to Reid's force [13]. Certain items like the exponential fall off are slighty different but this could be due to the pion range in the Yukawa exponential term being slightly longer which would provide almost full convergence.

4 Conclusion

All four fundamental forces use the same core equations. These forces use energy gradients based off their relative information horizons. Additionally, all forces use the Yukawa potential however the mediating particles for both the electromagnetic and gravitational force have a mass of zero therefore the exponential term tends to unity as previously discovered. The only varying parameters for each force depend on the topology of the configuration. The gravitational and electromagnetic force both use a constant of $4/(2\pi)$ while the weak and strong force use 1 and 2 respectively. The strong force has a slightly different form due to the fact that its range has a fixed end and beginning due to overlap of the nucleons. Overall, it seems that all four fundamental forces of the universe have a similar structure and their unification seems likely.

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References

[1] A. S. Bhatt and F. M. Becker. Neutrino mass replaces planck mass as fundamental particle. *vixra.org*, page 7, 2019.

[2] R. Bousso and S. W. Hawking. Pair creation of black holes during inflation. *Phys. Rev. D*, 54:6312–6322, Nov 1996.

[3] L. M. Brown. Hideki Yukawa and the meson theory. *Physics Today*, 39:55–62, Dec. 1986.

[4] G. Dungworth and M. Sheppeard. Non local mirror neutrinos with r=ct. 11 2017.

[5] P. D. Group. The particle adventure — what holds it together? — electroweak, Mar 2011.

[6] E. Haug. The gravitational constant and the planck units. a simplification of the quantum realm. *Physics Essays*, 29:558–561, 12 2016.

[7] S. W. Hawking. Evaporation of two-dimensional black holes. *Phys. Rev. Lett.*, 69:406–409, Jul 1992.

[8] A. Ivashov and D. Carpi. Smath studio, Mar 2019.

[9] M. Mcculloch. Gravity from the uncertainty principle. *Astrophysics and Space Science*, 349:410–, 11 2013.

[10] M. Mcculloch. Low-acceleration dwarf galaxies as tests of quantised inertia. 362, 03 2017.

[11] M. E. McCulloch. Minimum accelerations from quantised inertia. *EPL (Europhysics Letters)*, 90(2):29001, 2010.

[12] M. Planck. Naturlische masseinheiten. *Der Koniglich Preussischen Akademie Der Wissenschaften*, page 479, 1899.

[13] R. V. Reid, Jr. Local phenomenological nucleon-nucleon potentials. *Annals of Physics*, 50:411–448, Dec. 1968.

[14] K. Schwarzschild. Uber das Gravitationsfeld eines Massenpunktes nach der Einsteinschen Theorie. *Sitzungsberichte der Koniglich Preussischen Akademie der Wissenschaften (Berlin), 1916, Seite 189-196*, 1916.

[15] W. Unruh. Acceleration radiation for orbiting electrons. 307:163–171, 04 1998.

[16] W. G. Unruh. Notes on black-hole evaporation. *Phys. Rev. D*, 14:870–892, Aug 1976.

[17] H. Yukawa. On the Interaction of Elementary Particles. I. *Progress of Theoretical Physics Supplement*, 1:1–10, 01 1955.