Measurement Quantization as Applied to Gravitation with Formal Expressions for Special and General Relativity

Jody A. Geiger

30 E Huron Street
Chicago, IL 60611

E-mail: jodygeiger@hotmail.com
Phone: (312) 898-7988
ORCID: 0000-0001-5389-0447

(Submission Date: February 11, 2018)

Unifying quantum and classical physics has proved difficult as their postulates are conflicting. Using the notion of counts of the fundamental measures—length, mass, and time—a unifying description is resolved. A theoretical framework is presented in a set of postulates by which a conversion between expressions from quantum and classical physics can be made. Conversions of well-known expressions specific to gravitation, special and general relativity exemplify the approach and mathematical procedures. The postulated integer counts of fundamental measures changes our understanding of length and allows a straight-forward application of the principles of relativity to a gravitational field.

1. INTRODUCTION

A quantum expression for gravity will be presented. The approach recognizes the quantized nature of measurement and describes a process for translating mathematical descriptions into quantum form. We then present an expression for quantum uncertainty providing an understanding of what gives rise to quantum mechanics. Finally we use the principles of measurement quantization to resolve dilation expressions for Special and General Relativity (SR/GR) [1][2].

2. METHODS

We begin by refining our understanding of observation in terms of the three measures: length, mass and time. Where Einstein presented his work on SR, expressions that describe measure with respect to an inertial frame, we ask a more immediate question. What defines measure?

Consider measure as a count of a known reference, where the reference is recognized as that measure for which no smaller measure has physical significance. Where the reference defines our understanding of measure and where we may understand measure only relative to the reference, then we find ourselves in a referential paradox that does not allow fractional counts of measure. If there were a means to measure a fraction of the reference, then we violate our definition of a reference. Thus, the fraction would represent the reference where the prior becomes an error in assignment. We conclude that nature describes observation only as a whole-unit count of the reference.

Planck conjectured that there were physically significant units of measure [3]. His expressions for these fundamental values are recognized as Planck's Units [4][5] and are expressed with the constants G, c and Planck's reduced constant $\hbar$. Where Heisenberg's Uncertainty Principle [6] as applied to the position and momentum of a particle may be reduced to $n_M r_{Lf} n_L \geq l_f$ ([7] see Eq. (57)) it may be shown where support for the principle is found, then it must also be found that l_f is also physically significant, defining the threshold. In turn, where the speed of light is defined as a phenomenon such that l_f/t_f is constant, then the same observations may be used to resolve the physical significance of time and mass.

3. RESULTS

Forthwith, we will describe gravity in terms of quantized measure.

3.1. Gravity

We present a gedanken experiment in support of this conjecture. Where measure for the observer can be no more precise than a whole-unit count of the reference and where, by example, we may understand distance as described by the Pythagorean Theorem, then of what physically significance is any fractional result of this theorem.

We may consider any target where

$$c = \left(1 + b_{Lf}^2\right)^{1/2}, \tag{1}$$

$$Q_{Lf} = \left(1 + b_{Lf}^2\right)^{1/2} - b_{Lf}, \tag{2}$$

as described in Figure 1. Where our reference is always 1, then there is some known count b_{Lf} of the reference that resolves the unknown distance c between the observer and the target. Where Q_{Lf} is the fractional remainder then we find that $r_{Lf}=b_{Lf}$ for all counts.

Thus, multiplying by length l_f and dividing by time t_f places the expression in SI units. And finally multiplying by the speed of light c and dividing by the scalar constant S adjusts the expression for the metric expansion of space.

$$\frac{Q_{Lf} l_f}{r_{Lf} t_f^2} \frac{c}{S} = \frac{Q_{Lf} c^2}{r_{Lf} t_f S} = \frac{Q_{Lf} l_f c^2}{r_{Lf} l_f t_f S} = \frac{Q_{Lf} c^3}{rS}. \quad (3)$$

Where the fractional distance Q_{Lf} with respect to r_{Lf} is lost at each count of t_f, then the lost fractions describe the phenomenon of gravity in quantum form.

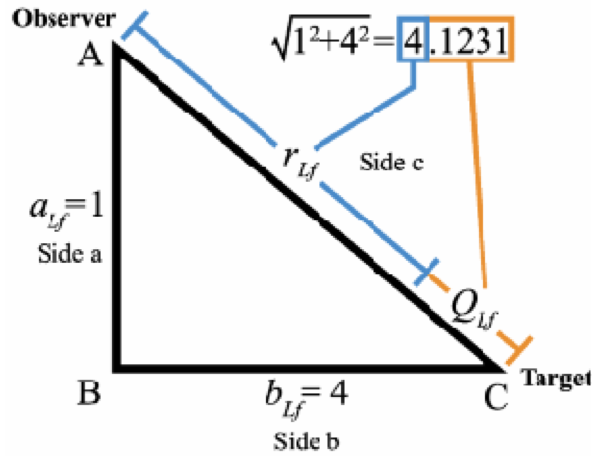

FIG. 1 Count of distance measures between an observer and target where $b_{Lf}=4$

We may set Newton's expression to be approximately equivalent to better understand their relation. Then

$$\frac{Q_{Lf} c^3}{rS} = \frac{G}{r^2}, \quad (4)$$

$$Q_{Lf} r c^3 = GS. \quad (5)$$

Thus, Newton's expression differs in quantum precision by the *Informativity differential* $Q_{Lf} r_{Lf}$ as numerically assessed in Table 1. Where distance exceeds a small count of l_f, the two expressions are physically indistinguishable (i.e. less than the reference).

TABLE 1. Informativity difference in G/r^2.

	$50\ l_f$	$100\ l_f$	$200\ l_f$	$300\ l_f$	$500\ l_f$	$1000\ l_f$
Difference	0.00100%	0.00250%	0.00062%	0.00028%	0.00010%	0.00003%

The value of S has been shown to be a macroscopically measured constant of nature equal to the angle necessary to quantum entangle light in specific Bell states of the polarized electric field of X-rays ([7] see Eqs. (10-17)). When compared to measures of this effect by Shwartz and Harris [8], the quantized expressions presented in Table 2 match their measurements.

TABLE 2. Angle setting in radians of the **k** vectors of the pump, signal and idler for maximally entangled states at the degenerate frequency with corresponding Shwartz and Harris values (Ref. [8]).

Bell's State	θ_p	θ_s	θ_i
$(\|H_s, V_i\rangle + \|V_s, H_i\rangle)/\sqrt{2}$	$(l_f c^3/2G)-\pi$ *(0.1208)*	$\pi - (l_f c^3/2G)$ *(-0.1208)*	$\pi - (l_f c^3/2G)$ *(-0.1208)*
	$2\pi - (l_f c^3/2G)$ *(3.02079)*	$(l_f c^3/2G)$ *(3.26239)*	$(l_f c^3/2G)$ *(3.26239)*

As such, we replace S with the symbol θ_{si} which is measured as 3.26239 radians. Unit analysis is a challenging subject and does require a greater understanding of self-defining and self-referencing measurement systems ([7] see Sec. 3.8), but may be resolved where the units are known from components resolved earlier in a derivation as values are the same regardless of these frames of reference.

3.2. The Fundamental Measures

Recognizing the physical significance of θ_{si}, the fundamental units of measure may now be resolved as a product of macroscopic measures. Where $Q_{Lf}r_{Lf}$=1/2 as shown in Appendix A, we may express length and then time as follows from the definition t_f=l_f/c. And that may be reordered to express mass.

$$l_f = \frac{2G\theta_{si}}{c^3} = \frac{2 \;\; 6.67408\;10^{-11} \;\; 3.26239}{(299792458)^3} = 1.61620\;10^{-35}\,\text{m}, \tag{6}$$

$$t_f = \frac{l_f}{c} = \frac{2G\theta_{si}}{c^4} = \frac{2 \;\; 6.67408\;10^{-11} \;\; 3.26239}{(299792458)^4} = 5.39106\;10^{-44}\,\text{s}, \tag{7}$$

$$m_f = t_f\frac{c^3}{G} = \frac{2\theta_{si}}{c} = \frac{2 \;\; 3.26239}{299792458} = 2.17643\;10^{-8}\,\text{kg}. \tag{8}$$

The fundamental expressions also combine to reveal the *fundamental expression*

$$l_f m_f = 2\theta_{si}t_f\,. \tag{9}$$

Notably, we may now express the gravitational constant as

$$G = \frac{Q_{Lf}rc^3}{\theta_{si}} = \frac{Q_{Lf}r_{Lf}l_f c^3}{\theta_{si}} = \frac{c^3 l_f}{2\theta_{si}} = \frac{c^3 t_f}{m_f} = \frac{l_f}{t_f}\frac{l_f}{t_f}\frac{l_f}{t_f}\frac{t_f}{m_f}\,. \tag{10}$$

Thus, G is the upper bound of mass with respect to time multiplied by the upper bound of length with respect to time in each of the three dimensions. The upper bounds to measure not only define what is observed, but establish the rules that compose all physical expressions. Einstein's model for SR, by example, arises from an understanding that the speed of light l_f/t_f is a physically significant bound. This model recognizes that mass frequency m_f/t_f is as well.

3.3. Quantum Uncertainty

Measurement quantization is not only capable of resolving an understanding of gravitation, but also presents an understanding of the geometric disciplines that give rise to quantum mechanics. Quantum uncertainty, as may be understood with this reduced expression ([7] see Eqs. (53-57)) for Heisenberg's description of quantum uncertainty

$$n_M r_{Lf} n_L \geq l_f \tag{11}$$

reveals that both measurement and certainty are an outcome of whole-unit limitations in a unit count of a base reference. While relations such as 1+1=2 l_f will precisely match the reference, relations such as 7/3=2.3333 l_f cannot be observed. The relation demonstrates uncertainty in observation and it is this as defined against the reference that gives rise to quantum phenomena.

3.4. Relativity

Measurement quantization may be applied to Einstein's dilation expressions, both SR and GR where recognizing the dilation metric $(1-(v^2/c^2))^{1/2}$ and substituting the respective fundamental measures. Where $\mathrm{n_{Lc}}$ is the count of l_f traveled by light in a second and n_L the count of l_f respective of v between the observer and target, then

$$\left(1-\frac{v^2}{c^2}\right)^{1/2} = \left(1-\frac{n_L^2 l_f^2}{n_T^2 t_f^2}\frac{n_T^2 t_f^2}{\mathrm{n_{Lc}^2} l_f^2}\right)^{1/2} = \left(1-\frac{n_L^2}{\mathrm{n_{Lc}^2}}\right)^{1/2}. \tag{12}$$

Where subscripts o identify the local frame and l the observed frame, then the corresponding quantized dilation expressions for SR are

$$t_o = t_l\left(1-\frac{n_L^2}{\mathrm{n_{Lc}^2}}\right)^{1/2}, \tag{13}$$

$$l_o = l_l\left(1-\frac{n_L^2}{\mathrm{n_{Lc}^2}}\right)^{1/2}, \tag{14}$$

$$m_o = m_l / \left(1-\frac{n_L^2}{\mathrm{n_{Lc}^2}}\right)^{1/2}. \tag{15}$$

Next, where escape velocity $v_e=(2GM/r)^{1/2}$ and where $G=t_f c^3/m_f$ from Eq. (10), then

$$v_e^2 = \frac{2GM}{r} = n_M m_f \frac{2}{r}\frac{t_f c^3}{m_f} = \frac{2n_M t_f c^3}{n_L l_f}, \tag{16}$$

$$v_e^2 = \frac{2n_M t_f c^3}{n_L l_f} = \frac{2n_M c^3}{n_L c} = \frac{2n_M c^2}{n_L}, \tag{17}$$

$$\frac{v_e^2}{c^2} = 2\frac{n_M}{n_L}. \tag{17}$$

We then adopt the same approach to describe dilation with respect to mass n_M (i.e. formal expressions for the relativistic effects described by GR).

$$t_o = t_l\left(1-2\frac{n_M}{n_L}\right)^{1/2}, \tag{19}$$

$$l_o = l_l\left(1-2\frac{n_M}{n_L}\right)^{1/2}, \tag{20}$$

$$m_o = m_l / \left(1-2\frac{n_M}{n_L}\right)^{1/2}. \tag{21}$$

While Einstein disliked the concept of relativistic mass [9], measurement quantization skirts the issue by describing measurement in a gravitational field as a geometric relation relative to the local frame.

4. DISCUSSION

Measurement quantization may also be used to describe the expansion of the universe (i.e. the distributions of dark energy, dark, observable, visible matter and their relation, to resolve the age, mass/energy, density and temperature of the cosmic microwave background ([7] see Eqs. (97, 103, 98, 101, 106, 140, 143, 144 and 146 respectively)). The model may be used to express all of the physical constants, recognizing them as constructs of the fundamental units.

In this paper, we have focused our presentation on expressions that describe gravity. We have expanded our understanding of quantum measure defining 'certainty' and in turn established a model with which to describe what gives rise to quantum phenomena. There are several experiments that validate this approach ([7] see Sections 4.1 – 4.4), but as presented from the outset, measurement quantization is a mathematical framework that takes established laws of nature and presents them in quantized form. They are more precise and their physical significance is rooted in the evidence already established with respect to the prior.

5. APPENDICES

Appendix A: Numerical limits to $Q_{Lf}r_{Lf}$

The product of $Q_{Lf}r_{Lf}$ is Eq. (2) multiplied by b_{Lf}.

$$Q_{Lf}b_{Lf} = \left(\sqrt{1+b_{Lf}^2} - b_{Lf}\right)b_{Lf} \,. \tag{A1}$$

With a=1 and b_{Lf}=r_{Lf} for all values, then

$$Q_{Lf}r_{Lf} = \left(\sqrt{1+r_{Lf}{}^2} - r_{Lf}\right)r_{Lf} \,. \tag{A2}$$

The lower limit where r_{Lf}=1 is easily produced, $lim_{r=1}f(Q_{Lf}r_{Lf})$ =√2-1. Conversely, if we divide by r_{Lf}, then add r_{Lf}, square, subtract $r_{Lf}{}^2$, and divide by 2, we find that

$$\frac{Q_{Lf}{}^2}{2} + Q_{Lf}r_{Lf} = \frac{1}{2} \,. \tag{A3}$$

Q_{Lf} decreases with increasing r_{Lf} until the left term drops out.

REFERENCES

[1] Albert Einstein, 1905, *Zur Elektrodynamik bewegter Körper*, (Electrodynamics of moving bodies) Annalen der Physik, 322 (10): 891–921. Bibcode: 1905 AnP...322..891 E. doi:10.1002 and p.19053221004.
[2] Albert Einstein, http://einsteinpapers.press.princeton.edu/vol6-trans/42, Vol. 6: The Berlin Years: Writings, 1914-1917 (English translation supplement), pg 30 (1914)

[3] M. Planck, *Über irreversible Strahlungsvorgänge*, *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften zu*, (About irreversible radiation events, meeting reports of the Royal Prussian Academy of Sciences), Berlin, 5, p. 480 (1899).
[4] P. Mohr, B. Taylor, and D. Newell, *CODATA Recommended Values of the Fundamental Physical Constants: 2010*, p. 73 (2012), arXiv:1203.5425v1.
[5] P. Mohr, B. Taylor, D. Newell, *CODATA Recommended Values of the Fundamental Physical Constants: 2014*, p. 3, (2015), arXiv: 1507.07956v1.
[6] L. E. Ballentine, *The Statistical Interpretation of Quantum Mechanics*, Rev. Mod. Phys. **42** 4. 358–381, Section 3.2 (1970).
[7] Jody Geiger, *Measurement Quantization Unites Classical and Quantum Physics*, (2018).
[8] S. Shwartz and S. E. Harris, *Polarization Entangled Photons at X-Ray Energies*, Phys. Rev. Lett. **106**, 080501 (2011), arXiv: 1012.3499.
[9] Bernard F. Schutz, *Gravity from the ground up*, Cambridge University Press, p. 361. ISBN 978-0-521-45506-0. (2003)