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## The case for a low energy gravitational scale

### Abstract

Arguments are presented that current difficulties with gravitational theory are resolved at a lower energy scale. Gravity is known to be the geometry of space time (general theory of relativity). It is generally accepted that the source of the gravitational constant (G) is the Planck scale. The fundamental relationship gives the Compton wavelength (for gravity the Planck length L),  $L = (\hbar * G / C^3)^{.5}$  as a function of the reduced Planck or Heisenberg constant ( $\hbar$  pronounced hbar), G and C the speed of light. The Compton wavelength is 1.61e-35 meters and this is associated with the Planck energy 1.2e22 mev. This energy scale is far above the energy of a proton and the space surrounding each proton after inflation is much above the Compton wavelength. Literature states that the Compton wavelength is nature's response to geometry and mass at the quantum scale. The quantum scale has so far been incorrectly identified and the large difference causes difficulties with gravitational theory including infinities and quantum foam like space.

### Nomenclature and review

	<u>Constants</u>		
$\hbar$	6.5821E-22	mev-sec	reduced Heisenberg
E	1.2200E+22	mev	Planck energy E
M	2.18E-08	kg	Compton mass
G	6.670E-11	nt m <sup>2</sup> /kg <sup>2</sup>	gravitational constant
C	3.00E+08	m/sec	
<u>Relationships</u>			
Compton wavelength=GM/C <sup>2</sup>			
GM/C <sup>2</sup>	6.67e-11*2.18e-8/3e8 <sup>2</sup>		
L=GM/C <sup>2</sup>	1.62E-35	meters	
L=Ch/E=h/MC	1.62E-35	meters	
L=h/MC=GM/c <sup>2</sup>	1.61E-35	meters	
G=hC/M <sup>2</sup>			

### A possible candidate for gravitational energy scale

First compare the quantum mechanical action at two levels, the Planck scale and a much lower level and note that either level could be a candidate for defining quantum gravity since the action is 1 in both cases.

Planck energy E (mev)	1.2200E+22
L=Planck length (meters)	1.62E-35
Planck momentum	p=E/C 4.07E+13
p*L	6.58E-22
qm action= p*L/h	1.00E+00
Low energy E (mev)	20.3
r=proton r (meters)	1.00E-14
Low E momentum p=E/C	6.77E-08
p*r	6.77E-22
qm action= p*r/h	1.0

Next, compare the calculation for gravitational constant for the Planck scale and the much lower level above and note that they differ by the large factor natural log e to the power 90;  $1/\exp(90)$ .

$$\begin{aligned} \text{Compton mass } & 2.18\text{e-}8 \text{ kg} \\ G &= hC/M^2 \\ G &= (h^3e8/(2.18\text{e-}8)^2*1.603\text{e-}13) \\ & 6.66\text{E-}11 \quad \text{nt m}^2/\text{kg}^2 \end{aligned}$$

$$\begin{aligned} G &= hC/M^2 \\ \text{Proton mass } & 6.24\text{e-}28 \text{ kg (proton mass w/o ke)} \\ G &= (h^3e8/(6.24\text{e-}28)^2*1.603\text{e-}13)/\exp(90) \\ & 6.66\text{E-}11 \quad \text{nt m}^2/\text{kg}^2 \end{aligned}$$

Next consider why  $1/\exp(90)$  is required for the same G. (later, the value  $6.24\text{e-}28$  kg is questioned and the relationship is replaced with a different source for G).

Consider large mass M broken into  $\exp(180)$  cells, each with the mass of a proton. Fill a large spherical volume with  $\exp(180)$  small spheres. In general relativity the metric tensor is based on  $(ds^2)$ . The surface area of a 2-sphere would be broken into many small spheres with an equal surface area. Let r represent the radius of each small cell and R represent the same surface area of one large sphere containing  $\exp(180)$  cells. Position a proton on the surface of each cell (and one in the center?). The total energy will be that of 1 (or 2) protons/cell plus a small amount of kinetic energy. *At a particular time in expansion*, we may either consider the energy density of the whole or the energy density of the many cells. We will evaluate the energy density of large sphere and compare it with the energy density of many small cells. Note that for volume we are considering a filled sphere and big V is proportional to  $R^3$  and this is equal to small v with  $\exp(180)*r^3$ . This makes  $R=r*\exp(60)$  for the volume substitution.

$$\begin{aligned} \text{Area} &= 4 \pi R^2 \\ \text{Area} &= 4 \pi r^2 * \exp(180) \\ A/A &= 1 = R^2/(r^2 * \exp(180)) \end{aligned}$$

$$R^2=r^2*\exp(180)$$

$$r=R/\exp(90)$$

$$M=m*\exp(180)$$

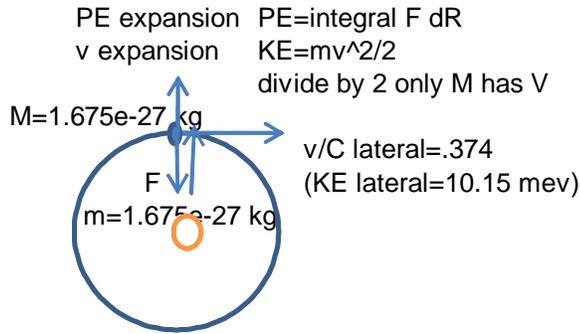
For gravitation, we consider velocity V, radius R and mass M as the variables that determine the geodesic. With G constant,  $M=m*\exp(180)$  and  $R=r*\exp(90)$  the gravitational constant would be calculated for large space and proton size space as follows:

at any particular time in expansion	
large space	proton size space
$RV^2/M=$	$G=G$
	with substitutions $r*\exp(90) *v^2/(m*\exp(180))$ $(rv^2/m)/\exp(90)$

Note the factor  $1/\exp(90)$ . When measurements are made at the large scale as must to determine G, the above derivation indicates that we should apply the factor  $1/\exp(90)$  to the quantum scale if we expect the same G.

There is a historical perspective to this understanding. When physicists dealt with one electron and its field energy, they knew they were working with the quantum scale and it was reasonable to assign a Compton mass and wavelength with the above relationships. However, early physicists did not understand that gravity is the geometry of space time and furthermore could only make large scale measurements. It was reasonable, as a working assumption, to assign a Compton wavelength to mass and calculate Planck scale energy. However, it now must be recognized that for equal gravitational constant the radius of curvature and mass are vastly different between the large and small scale and that the Planck scale is a historical tool. A full analysis of this is included [2]. It was unfortunate that the great physicists of the 1900's did not have the advantage of WMAP [5] and Cmagic [6] expansion models, nor did they have the advantage of knowing the number of protons in the universe, which we can estimate at  $\exp(180)$  from the mass part of WMAP critical density.

## Proposed model for expansion



PE expansion PE=integral F dR  
KE=mv^2/2

M=1.675e-27 kg  
v/C lateral=.374  
(KE lateral=10.15 mev)  
m=1.675e-27 kg

If this picture won't go through the internet it shows a circle with a proton in the center and one on the circumference with kinetic energy moving around the circle. Expansion is outward.

The initial lateral velocity is associated with a proton with 10.15 mev orbiting a central proton. The radius of this orbit is found as the geodesic. With G constant at 6.67e-11 m^2/kg^2, the radius is:

V	m/sec	1.14E+08	
m	kg	1.67E-27	
R=Gm/V^2*exp(90)	m		1.05E-14

S.K. Kauffmann [3] gives the following value for energy.

Radius	1.21E+26	
	2(c^4/g)r	
	2.93E+70	
	m^4/sec^4(kg^2/(nt m^2))*m	
	m^4/sec^4kg^2/(nt m*m)*m	
	4.69E+57	
	m^4/sec^4kg^2 m/(mev*m)	
	1.48E+117	
	m^4/sec^4 mev^2 m/(mev*m)	
	m^4/sec^4 mev	
Energy	1.82E+83	mev
Volume	7.35E+78	m^3
	2.48E+04	mev/m^3
number protons	1.49E+78	

4.93E+00      mev/proton

If the above energy value is divided by exp(180) protons, the result is about 5 mev/proton. The value 10.15 mev/proton [1][2] and the value above compare favorably.

### Current kinetic energy per proton

The proton orbit model allows an evaluation of the kinetic energy during expansion. The derivation below is based on the gravitational constant remaining at the value G.

$$\begin{array}{l}
 RV^2/(M/g) \quad G=G \quad rv^2/(M/g_0) \\
 \text{But the universe expands and } r=1e-14 \text{ is scaled up by time}^{(2/3)} \\
 \text{R space becomes } r \cdot \text{time}^{(2/3)} \\
 \text{what happens to } v^2 \text{ so that } G=rv^2/M \text{ remains constant when } r \text{ expands?} \\
 \begin{array}{llll}
 RV^2/M=rv^2/m & 10.15 \text{ ke} & & ke=.5 (m/g)v^2 \\
 RV^2=rv^2 & & & ke_0=.5 (m/g_0)V^2 \\
 (v/V)^2=(r/R) & \text{velocity falls} & \downarrow & ke/ke_0=(m/g)v^2/((m/g_0)V^2)=r/R \\
 & 0 & & ke/ke_0=(g_0/g)(v/V)^2 \\
 & & & ke=ke_0(g_0/g)(r/R)
 \end{array}
 \end{array}$$

With the initial ke=10.15 mev, the current value would be  $10.15 \cdot 1e-14 / .771 \text{ mev} = 1.3e-13 \text{ mev/proton}$  associated with  $v=13.4 \text{ m/sec}$  since the appropriate expansion values are  $1e-14 \text{ m}$  at the beginning and the expanded scale is  $0.77 \text{ meters}$ . Recall that each cell scales to large radius by the factor  $r \cdot \exp(60)$ .

### Argument #1: The cell radius 0.77 m scales to the current size of the universe with conservation of energy

Below is the first of several arguments that exp(90) must be used as a correction factor at the quantum scale.

Assuming only that G is constant, big R can be estimated as follows. Small r is scaling up the velocity ratio and mass ratio in the two columns below and the result is divided by exp(90). Recall that small  $r \cdot \exp(60)$  estimates the current size of the universe ( $0.77 \cdot \exp(60) = 8.8e25 \text{ meters}$ ).

NOW	Scaling the geodesic to universe sized space				
R is the universe size geodesic		R'V^2/M	G=G	rv^2/m	r is the proton size geodesic
		G from m=1.67e-27 kg			
	M=m*exp(180)	2.49E+51		1.67E-27	kg
R=r*(v/V)^2*(M/m)/exp(90)	R	8.82E+25		7.71E-01	r
	V	4.37E+07		1.34E+01	v
					r*exp(60) m 8.80E

	(meters/sec)		(meters/sec)
	G	6.76E-11	6.76E-11

Big V (4.37e7 m/sec) is associated with my kinetic energy of 10.15 mev and the following calculation shows that the original energy is enclosed in the volume, just diluted.

VOL=4/3*PI()*8.8e25^3	m^3	2.88E+78
KE (mev)=2.49e51*4.37e7^2*(1)/1.603e-13/2		1.48E+79
KE/Vol	mev/m^3	5.16E+00

The same calculation for small r is as follows, but this time for original energy.

vol (m^3)=4/3*PI()*0.771^3	1.91978124
ke=10.15 mev	10.15
ke/vol	5.29E+00

Note that the original energy is conserved and it agrees substantially with Kauffmann [3] on a per particle basis (two particles in this 1.9 m^3 volume bring it to 2.6 mev/particle).

The scaling estimate for R is repeated below except it does *not* include exp(90) as a divisor.

NOW	Scaling the geodesic to universe sized space				
R is the universe size geodesic	R'^V^2/M	G=G	rv^2/m	r is the proton size geodesic	
	G from m=1.67e-27 kg				
	M=m*exp(180)	2.49E+51	1.67E-27	kg	
R=r*(v/V)^2*(M/m)	R	8.82E+25	6.31E-40	r	r*exp(60) m
	V (meters/sec)	4.37E+07	1.34E+01	v (meters/sec)	7.21E-14
	G	6.76E-11	6.76E-11		

To match G with G, the radius r=.771 was divided by exp(90) to maintain the original energy density of about 2 mev/particle. There are at least two problems here. First, the radius of the universe currently can be only 7.2e-14 meters (6.3e-40\*exp(60)). Second, the energy density is too high. Our 2 particles now contain 6.7e117 mev/m^3.

## Argument #2: Agreement with the Schwartzschild radius

It is demonstrated below that scaling with 1/exp(90) in the denominator exactly matches the Schwartzschild calculation.

For one solar mass in universe sized space.

NOW	Scaling the geodesic to universe sized space				
R is the universe size geodesic		$R'V^2/M$	$G=G$	$rv^2/m$	r is the proton size geodesic
		G from $m=1.67e-27$ kg			
	$M=m*\exp(180)$	2.00E+30		1.67E-27	kg
$R=r*(v/V)^2*(M/m)/\exp(90)$	R	1.50E+03		7.71E-01	r
	V	3.00E+08		1.34E+01	v
	(meters/sec)				(meters/sec)
	G	6.76E-11		6.76E-11	
					$r*\exp(60)$
					m
					8.80E

In these calculations, big  $V=C$  and the result is the Schwarzschild radius (S) for the proton mass and the solar mass and the divisor  $\exp(90)$  is utilized. This indicates that the values 13.4 m/sec and  $r=0.77$  are special. Of course, regular mass rather than Compton mass is used in the S equation below. The equation for S is:

$$1=1/(2M-r) \quad \text{term in solution}$$

$$2M-r=1 \quad M \text{ is metric}$$

$$r=2M$$

$$M=G m/C^2 \quad m \text{ is mass}$$

$$S=2Gm/C^2 \quad \text{singularity}$$

This equation is twice the Compton wavelength  $r=GM/C^2$  (M is mass here, not the metric above). With  $G=r C^2/M$  this is the same equation in the box above  $G=RV^2/M$ .

	m
$S=2GM/c^2=1.48e-27*m$	2.96E+03
My Geodesic at C and High M	1.50E+03
$S=2Geodesic$	3.00E+03

### Argument #3: Gravity is long range because of $1/\exp(90)$

There is a third piece of Argument that the energy scale is low related to gravity being long range. To understand this argument, a source of gravity is proposed as follows:

An attempt to understand nature and its energy components with the use of information theory [1] has been the focus of the author. The analysis shows that a total mass and kinetic energy of 959.6 mev is balanced against 959.6 mev of field energy. One of the models developed is entitled the "proton mass model" [1] and is included as Appendix 1. Constants for four fundamental forces (interactions) come from the table. The proton mass model gives a value of 20.3 mev for a kinetic energy associated with a proton but

not part of its mass. This can be associated with expansion with the remaining positive energy making up the neutron that decays to a proton. (The 20.3 meV becomes 10.15 kinetic and 10.15 potential as the orbit forms and then 20.3 meV potential energy again after expansion occurs). The radius  $1e-14$  meters is calculated from the proton mass model values for gravity. It is proposed that this is the source of the gravitational constant  $G$  and it approaches the value accepted value  $6.67e-11$  during expansion.

Particle Mass (meV)	129.541
m (kg) (proton w/o its ke)	2.309E-28
Field Energy E (meV)	2.683
kinetic energy ke (meV)	10.151
Gamma (g)=m/(m+ke)	0.9273
Velocity Ratio $V/C=(1-(g)^2)^{.5}$	0.3742

"R equation output"--meters	$R=(HC/(2\pi)/(E*m/g)^{0.5}$	1.0584E-14
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Calculation of gravitational constant from inertial force

Velocity Ratio $V/C=(1-(g)^2)^{.5}$	0.374
Radius r (Meters)	1.0584E-14
Mass (kg) (proton)	1.673E-27
Inertial Force= $F=(m*V^2/r)*1/EXP(90)$	1.6300E-36
Gravitational Constant ( $G=F*r^2/m^2=nt\ m^2/kg^2$ )	6.5269E-11

Since the four interactions have similar form, each with a characteristic radius calculated from the proton mass model, we would expect all four interactions to be short range. Gravity is known to be not only weak but very long range. The Heisenberg uncertainty principal can be written  $dh$  proportional to  $dx*dp$ , where  $dx$  is the radial scale and  $dp$  is the momentum scale. If the factor  $1/exp(90)$  is applied to the momentum scale,  $dx$  would be multiplied by  $exp(90)$  and gravity would be long range.

If this is the true source of gravity, it would also be considered the source of space itself. Its radius would be small at the beginning but now large.

#### Argument #4: Expansion kinetic energy comparisons are correct

Since the expansion history is now known [5][6], incremental calculations can be carried out on a particle by particle basis. If we put one proton in the center of a cell and another on the surface, the gravitational force can be calculated between them. With  $1e-14$  meters as the cell radius, the force is calculated to be  $1.7e-36$  Newtons. As the cell expands (driven by  $time^{(2/3)}$  and  $time^{(5/3)}$ ), the force changes and an integration of the increasing potential energy can be easily carried out. Based on this the potential energy per particle is now  $1.17e-37$  meV. (The initial radius of the sphere containing the particles was initially  $1.2e12$  meters, the radius now is  $8.8e25$  meters and the first  $1.2e12$  meters is addressed in under the heading Argument#5. Derivations that end with

$(v/r)^2 = 8/3 \pi G \rho$  start with the assumption that initial kinetic energy will become potential energy as expansion occurs. Calculate kinetic energy at the beginning. This can't be done with big R because the velocity is greater than the speed of light; hence the wisdom of carrying this out on a proton by proton basis (small r that is  $R/\exp(60)$ ). Since the expansion rate at  $1.2e12$  meters is known, we have a velocity ( $dr/dt = 6.35e-12$  m/sec) and from this a kinetic energy of  $2.3e-37$  mev. Since the particle on the cell surface is the only one with kinetic energy, divide the  $2.3e-37$  mev by 2 and compare  $1.15e-37$  mev of initial kinetic energy with  $1.17e-37$  mev of potential energy now. The two values match and we might conclude that there is no missing energy (dark energy) and that the central proton like mass is rather odd. Dr. Kauffmann has pointed out [7] that the central mass must be neutral. The kinetic energy and potential energy calculated as if expansion were outward from a center are too low. Using the proposed model above, kinetic energy is depleted by expansion and potential energy/particle on the order of 10 to 20 mev. It is quite common that orbit found in nature contain several mev/particle.

### **Argument #5: A lower limit on radius is established**

What about expansion from 0 to  $1e-14$  meters? By keeping G constant and expanding according to a geodesic nature limits the lower radius of a single cell.  $R = Gm/V^2$  is a minimum at  $V=C$  with m fixed, somewhat below  $1e-14$  meters.

A low energy scale is problematic for inflation and it proposed that inflation is simply duplication on one cell by the large number  $\exp(180)$ . Post inflation the radius of the universe would be  $1.2e12$  meters ( $\exp(60) * 1e-14$  meters).

### **Reality check**

The proposal that a proton could be orbiting another proton seems too simple and as Steven Kauffman [7] has pointed out it would be highly unlikely at the beginning from an electrostatic standpoint and would probably be disturbed by magnetic moment interactions. If the central proton like mass were neutral, the electrostatic repulsion would be limited to external forces on the expanding "orbit" and the protons would be imbedded in a sea of other protons with similar repulsion. The repulsion would balance overall, perhaps compress space temporarily but eventually return the energy. At about  $8e22$  meters the plasma cleared and electrons were able to assume an orbit about the proton (the SAHA equation). Before that time, the universe would be considered a gas. In plasma electrons are close to the protons.

It is possible however if the particles have the right energy at the beginning the overall physics suggested occurs without an orbit. Expansion is driven by time and the orbit does not have to control expansion, only respond to it. Nature consists of many orbits. On the small scale Luis deBroglie would describe quantum physics as orbits and on the large scale nature gravity eventually dominates because the electrostatic forces are short range and balance (just observe the galaxies and planets). The odd nature of the central

mass is interesting. The current working assumption for dark matter is that except for mass, it has few properties.

## Summary

Arguments were presented that a low energy gravitational scale is reasonable. Should the foundational relationship  $r = (\hbar G/C^3)$  be preserved? It would require the correction  $r = (\hbar G \exp(90)/C^3)^{.5}$ . The wavelength would be associated with a mass close to the proton (350 mev) but this difference from the proton (938 mev) makes one suspicious of the relationship altogether. A new source for the gravitational constant G was proposed and using this as a foundational principle sheds new light on the origin of space time itself. At the low energy scale it could be trouble free and simple but more work is required.

## References:

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5. Bennett, C.L. et al. *First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Results*, Astrophysical Journal, 2001
6. A Conley, et al., *Measurement of Omega from a blind analysis of Type IA supernovae: Using color information to verify the acceleration of the universe*, the Supernova Cosmology Project, [conley@astro.utoronto.ca](mailto:conley@astro.utoronto.ca)
7. Private communication.

## Appendix 1

ll g228 mass ke	CALCULATION OF PROTON MASS				Mass and Kinetic Energy				Field Energies			
	Energy-mev	strong field grav field	Energy-mev	Mass mev	Difference ke mev	Strong residual ke mev	Neutrinos mev	Expansion ke mev	Strong & E/M field energy	Gravitational Energy		
15.432	101.947	17.432	753.291	101.947	641.880							
12.432	5.076	10.432	0.687									
13.432	13.797	15.432	101.947	13.797	78.685							-0.69
12.432	5.076	10.432	0.687									-0.69
13.432	13.797	15.432	101.947	13.797	78.685							-0.69
12.432	5.076	10.432	0.687									-0.69
			-0.296				10.151				20.303 expansion ke	
charge		equal and opposite charge	-2.72E-05								0.000 expansion pe	
10.408	0.67	0.075		0.000	0.000		-0.671	→	0.671 v neutrino			
-10.333	0											
states here to form proton and electron				129.541	799.251							
10.136	0.51	10.333	0.62	<b>0.511</b>	0.111						5.44E-05	-0.622
0.197	2.47E-05	0.296	2.72E-05	<b>ELECTRON</b>				→	2.47E-05 e neutrino			
				130.052	0.111						0.671	20.303
90.000		90.000									Total m+ke	Total fields
											Total positive	Total negative
											959.868	-959.868
												0.00E+00

Note the values extracted from the model above.

	Mass (m) (mev)	Ke (mev)	gamma (g)	R meters	Field (E) (mev)
Gravity	129.541	10.151	0.9273	<b>1.0192E-14</b>	-2.683
Electromagn	0.511	1.36E-05	0.99997	<b>5.2911E-11</b>	-2.72E-05
Strong	129.541	799.251	0.1395	<b>2.0928E-16</b>	-957.18
Strong resid	928.792	10.151	0.9892	<b>1.4292E-15</b>	-20.303