

Gene H. Barbee
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The Source of the Gravitational Constant at the Low Energy Scale

Abstract

In general relativity, gravity is attributed to the geometry of space-time. Literature states that the gravitational constant (G) originates at the Planck scale. The Compton wavelength (Planck length) $L=(\hbar^*G/C^3)^{.5}$ is $1.61e-35$ meters and this is associated with the Planck energy $1.2e22$ MeV. This energy is far greater than the energy of a proton and the space surrounding each proton is far greater than the Compton wavelength. It is generally accepted that the Compton wavelength is nature's response to geometry and mass at the quantum scale. In this paper, the author discusses the hierarchy of interactions with a focus on gravity, propose a low energy scale source of the gravitational constant, and identify a more fundamental coupling constant with the value $1/\exp(90)$. A unique cellular approach is used to model expansion. A cell is the space associated with a proton mass and has cosmological properties that allow it to represent the universe geometrically. Each cell has an initial radius of $7.22e-14$ meters and, if it expands according to the concordance model with WMAP parameters, its current value is 0.54 meters. WMAP data allows one to estimate the numbers of protons in the universe. By using this approach, it is possible to compare the kinetic energy that expands cells with potential energy. Implications for the fraction of dark energy, baryons and cold dark matter are discussed. Several examples involving the use of the value $1/\exp(90)$ are presented that demonstrate how cellular values predict large scale observations.

Key Words: gravitational constant, cellular approach, cosmology, WMAP.

Hierarchy of Interactions

Calculation of gravitational force with accepted coupling constant

The gravitational coupling constant α_G is the coupling constant characterizing the gravitational attraction between two elementary particles having nonzero mass. α_G is a fundamental physical constant and a dimensionless quantity, so that its numerical value does not vary with the choice of units of measurement:

$$\alpha_G = Gm_e^2/(\hbar C) = (m_e^2/m_p^2) = 1.752e-45$$

where G is the Newtonian constant of gravitation; m_e is the mass of the electron; C is the speed of light in a vacuum; \hbar is the reduced Planck constant; m_p is the Planck mass.

This coupling constant can be understood as follows:

http://en.wikipedia.org/wiki/Gravitational_coupling_constant	
$\alpha G = (m_p/m_e)^2 = 1.752e-45$	
$m_p/m_e = 1836.15$ where $m_p/m_e = \text{proton/electron}$	
$\alpha G = 1836.15^2 * 1.752e-45 = 5.907e-39$	
$F = (5.9068e-39) * hC/R^2$	

If R for the force calculation is $7.22e-14$ meters, as proposed above, the force is:

$F = (5.9068e-39) * hC/R^2$			
hbar		6.5821E-22	mev-sec
hbar in NT-m-sec		1.05E-34	NT m sec
hbarC in NT-m^2=K		3.16E-26	NT m^2
$F = (5.9068e-39) * K/R^2$			
$F = (5.9068e-39) * 3.16e-26 / (7.22e-14)^2 = 3.58e-38$ NT			
3.579E-38	NT		

This result agrees with the simple Newtonian force:

$F = Gmm/R^2$ (nt) = $6.67428e-11 * 1.6726e-27^2 / 7.224e-14^2 = 3.666e-38$ nt

Ref. [1] is the author's attempt to unify fundamental interactions. WMAP data [5] was used to estimate the number of protons in the universe. The possibility that the result $\exp(180)$ was significant in other ways was explored. Note: The author uses the term proton to mean proton like mass in the work below. This is necessary because later in this document proton like mass is separated into protons and cold dark matter. Using an information based approach [8], energy components were identified that allowed the author to model the mass of a neutron and proton.

The proton is thought to be a primary manifestation of the underlying laws and as such contains information that determines many aspects of nature. The Proton Mass model is the source of constants for unification of forces in the table above.

Neutron and Proton mass models

First an abbreviated model is shown for the neutron. The abbreviated model (full model in Appendix 1) adds the three quark masses together. They total 130.163 MeV. Then, we add together the three quark kinetic energies. They total 799.25 MeV. The three quarks are imbedded in a strong field labelled -957.185 and a gravitational field energy labelled -2.732 MeV. The total field energy for the entire table is -959.92 MeV. This is lower than the known Neutron mass 939.565 MeV and the "missing energy" is a potential energy field -20.3 MeV. The quarks with their kinetic energy fall into the field and gain 10.15 MeV from their fall. The neutron subsequently falls to a radius $7.22e-14$ meters. It originally had kinetic energy 20.3 MeV but when the gravitational orbit was established, the ke was about 10.15 and the potential

energy was about 10.15. The neutron plus its associated gravitational energy balances the total table energy 959.92 MeV.

r20 uc2				
Mass and Kinetic Energy			Field energy	
Mass	KE	Strong	Strong	Gravitational
Quarks		Residual	field energy	Energy
MeV	MeV	Field	MeV	MeV
Strong	130.16	799.25	-957.18	-2.73
Strong Residual KE		10.15		
Neutron		939.57	-20.35	-959.92
neutrinos		0.05		
Gravitational ke		10.15		
Gravitational pe		10.15		
Total		959.92		

The proton model is reviewed in Appendix 1.

The table gives the field energy 2.732 MeV as the basis for gravitation. The proposal below indicates that this field energy is associated with a radius of 7.22e-14 meters. The test for quantum level is action. Action is 1.0 when momentum*radius/h=pR/h=1. The proposal meets the test by definition. One question this paper addresses is: Can we substitute this low energy scale for the Planck scale energy?

Proposal (cell d305 "unified")			
Field Energy		2.732 mev	
constant	HC/(2pi)	1.97E-13	mev-m
	R=constant/E	7.22E-14	m
	Field side	R side	
	H/E	2*pi*r/C	
time (t)	1.51E-21	1.51E-21	sec
Proposal p (p=E/C)		9.11E-09	mev-sec/m
p*R/h		1.00	
qm test	M/C^2*R^2/t	6.58E-22	mev-sec
qm test/h	M/C^2*R^2/t/h	1.00	

Gravity is attributed to the geometry of space-time in general relativity. If a proton with potential energy falls into the above field and follows the radius 7.22e-14 meters we would expect an orbit to be established.

GRAVITY			
		proton	neutron
Neutron Mass (mev)		938.2720	939.565
Neutron Mass M (kg)		1.673E-27	1.675E-27
Field Energy E (mev)		2.732	2.732
Kinetic Energy ke (mev)		10.111	10.140
Gamma (g)=M/(M+ke)		0.9893	0.9893
Velocity Ratio v/C=(1-g^2)^0.5		0.1456	0.1457
R (meters) =(HC/(2pi)/(E*E)^0.5		7.224E-14	7.224E-14
Inertial Force (F)=(M/g*V^2/R)*1/EXP(90) N		3.656E-38	3.666E-38
HC/(2pi)=1.97e-13 mev-m			
Calculation of gravitational constant G			
G=F*R^2/(M/g^2)=NT m^2/kg^2		6.6739E-11	6.6743E-11
Published by Partical Data Group (PDG)		6.67E-11	6.6743E-11

These forces are in agreement with the published coupling constant derived force and the Newtonian force $3.4527e-38$ NT. Inertial force $mV^2/R*1/exp(90)$ equals field force $E/R*1/exp(90)$. The match (highlighted in yellow) is for the quantum scale and the value $1/exp(90)$ is explained below under the heading “Scaling Cellular Gravitational Values to Large Scale Gravitation”. Several implications are explored in this paper. Firstly, space at the quantum level is defined by $7.22e-14$ meters. Secondly, a balanced force orbit defines a geodesic in which the gravitational constant is defined by the inertial force. Thirdly, the gravitational coupling constant is replaced by the value $1/exp(90)$ and fourthly, gravitation is associated with $exp(180)$ proton like masses.

Before considering gravitation more thoroughly, it is instructive to review other interactions supported by information extracted from the proton mass model. An updated table from [1] is reproduced below:

Force Table			Strong MeV	Strong Residual	Gravity proton	Electro- Magnetic
		(Higgs ref)	128992.05			
Field Energy E (mev)			957.18	20.303	2.732	2.72E-05
Particle Mass (mev)			129.54	928.120743	938.272	0.511
Mass M (kg)			2.31E-28	1.6545E-27	1.673E-27	9.11E-31
Kinetic Energy (mev)			798.58	10.1513	10.110	1.361E-05
		Rydberg energy from PDG				1.361E-05
Gamma (g)=m/(m+ke)			0.1395	0.989	0.989	1.000
Velocity Ratio	v/C=(1-(g)^2)^.5		0.9902	0.1467	0.1456	0.0073
R (meters) =((hC/(2pi))/(E*M/g)^0.5)			2.0928E-16	1.430E-15	7.224E-14	5.291E-11
Force	F=E/R*1.6022e-13		7.1E+05	2275.20	**	8.242E-08
Inertial	F=M/g*V*2/R nt		7.1E+05	2262.9	3.656E-38	8.24E-08
					1/exp(90)	

The conventional physics and comparison data is shown below.

Force Table			Strong MeV	Strong Residual	Gravity proton	Electro- Magnetic
Inertial	F=M/g*V*2/R nt		7.1E+05	2262.9	3.656E-38	8.24E-08
					1/exp(90)	
Force=3.16e-26/Range^2 (nt)			7.2E+05	15459.4	**	1.1E-05
Derived coupling constant			1.0157	0.1472		136.959
Published coupling constant (PDG)						137.036
Derived c^2 (E*R) mev m			2.00E-13	2.90E-14		1.44E-15
Derived c^2 joule m			3.21E-26	4.65E-27		2.31E-28
Derived exchange boson (mev)			942.881	138.019		0.004
*Published c^2 (E*R) mev m				1.5604E-14	1.17E-51	1.442E-15
*Published c^2 joule m				2.5E-27	1.87E-64	2.31E-28
*Published Range (m)					8.98E+25	5.291E-11
* http://www.lbl.gov/abc/wallchart/chapters/04/1.html						
** See text						

The field energies for three strong (color) interactions and their associated particles are from the proton mass table. They are referenced to the Higgs energy since it is considered by many to be the source of field energies and particle masses. A force coupling constant is calculated to be 1.00 and derived c^2 (E*R) values are presented in MeV-m and joule-m. The author did not find published values for comparison (quarks are not independently observable). The lower hierarchy electromagnetic coupling constant is well known and the author's calculations substantially agree.

The traditional relationship $F=hC/R^2$ is too simple to characterize gravity since gravity involves defining a radius and a proton with potential energy falling to that radius. Justification for replacing the coupling constant with the value $1/exp(90)$ is presented below.

The atomic binding energy curve is considered to be a result of the strong residual interaction. Again, the proton mass model provides information. The key value is the kinetic energy 10.151 MeV associated with the proton. The strong residual force $F = \hbar C / R^2 = 15467 \text{ NT}$ requires the coupling constant 0.147 and the derived $c^2 = 2.9 \times 10^{-14} \text{ MeV m}$ is similar to the published value $1.56 \times 10^{-14} \text{ MeV m}$. Also the radius of the proton appears to be credible. Reference 9 describes a simple model using the value 10.15 MeV as the basis for binding energy. In this model 10.15 MeV is the kinetic energy that changes as atoms fuse. ($928.121 \text{ MeV} + 10.151 \text{ MeV} = 938.272 \text{ MeV}$).

A possible candidate for gravitational energy scale

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 ² /kg ²	gravitational constant
C	3.00E+08	m/sec	
<u>Relationships</u>			
Compton wavelength = GM/C^2			
GM/C^2	$6.67 \times 10^{-11} \times 2.18 \times 10^{-8} / 3 \times 10^8^2$		
$L = GM/C^2$		1.62E-35	meters
$L = \hbar C / E = \hbar / MC$		1.62E-35	meters
$L = \hbar / MC = GM / c^2$		1.61E-35	meters
$G = \hbar C / M^2$			

First compare the quantum mechanical action at two levels, the Planck scale and the much lower level (2.732 MeV) proposed above. 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
$L = \text{Planck length (meters)}$		1.62E-35
Planck momentum	$p = E/C$	4.07E+13
$p * L$		6.58E-22
qm action = $p * L / \hbar$		1.00E+00

The proton mass ($1.67 \times 10^{-27} \text{ kg}$) is analogous to the Compton mass, i.e. proposed mass is 938.27 MeV, not $1.22 \times 10^{22} \text{ MeV}$ ($1.67 \times 10^{-27} \text{ kg}$, not $2.17 \times 10^{-8} \text{ kg}$). Compare the calculation for gravitational constant for the Planck scale and the proposed mass level and note that they differ by the large factor.

Compton mass $2.18 \times 10^{-8} \text{ kg}$

$$G = \hbar C / M^2$$

$$G = (6.58e-22 * 3e8 / (2.18e-8)^2 * 1.603e-13)$$

$$6.66E-11 \quad \text{nt m}^2/\text{kg}^2$$

$$G = hC/M^2$$

Proposed mass 1.67e-27 kg

$$G = (6.58e-22 * 3e8 / (1.67e-27)^2 * 1.603e-13) / \exp(88.03)$$

$$6.66E-11 \quad \text{nt m}^2/\text{kg}^2$$

The large factor required for the same G does not agree with the proposed coupling constant $\exp(90)$. I justify the value $\exp(90)$ below.

Scaling Cellular Gravitation Values to Large Scale Gravitation

Consider large mass M (for our purposes the mass of the universe although this is quite presumptive) broken into $\exp(180)$ cells, each with the mass of a proton. Fill a large spherical volume with $\exp(180)$ small spheres. We are considering the surface of many small cells as a model of the surface of one large sphere. For laws to be uniform throughout the universe there can be no preferred position. A surface offers this property but the equivalent surfaces of many small spheres also offer this property as long as we do not distinguish an edge. As such a “many small cells” surface model is useful if the fundamentals of each cell are known.

In general relativity the metric tensor is based on (ds^2) . The surface area of a 2-sphere can be broken into many small spheres with an equal surface area. Let small r represent the radius of each small cell and big R represent the radius of one large sphere with the same surface area containing $\exp(180)$ cells. Position a proton like mass on the surface of each cell. The total energy will be that of one protons/cell plus a small amount of kinetic energy. We will evaluate the gravitational constant G of a large sphere and compare it with G of many small cells.

$$\text{Area} = 4 \pi R^2$$

$$\text{Area} = 4 \pi r^2 * \exp(180)$$

$$A/A = 1 = R^2 / (r^2 * \exp(180))$$

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

$$r = R / \exp(90) \quad \text{surface area substitution}$$

$$M = m * \exp(180) \quad \text{mass substitution}$$

For gravitation and large space, we consider velocity V, radius R and mass M as the variables (capital letters for large space) that determine the geodesic. With G constant, $M = m * \exp(180)$ and the surface area substitution $R = r * \exp(90)$, the gravitational constant would be calculated for large space and cellular space as follows (small r, v and m below are for cellular space):

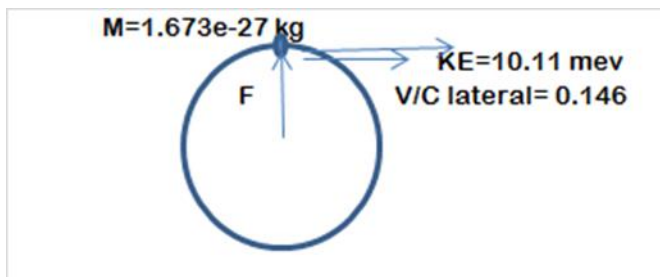
At any time during expansion		
<u>Large space</u>		<u>Cellular Space</u>
		With substitutions:
		R=r*exp(90) and M=m*exp(180)
R*V^2/M=	G=G	r*exp(90)*V^2/(m*exp(180))
R*V^2/M=	G=G	(r*v^2/m)/exp(90)

This is the source of $1/\exp(90)$. When measurements are made at the large scale as must be done to determine G , the above derivation indicates that we should multiply cell scale values (rv^2/m) by $1/\exp(90)$ if we expect the same G . Geometric and mass relationships give the cell “cosmological properties”.

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 an electromagnetic based Compton mass and wavelength. However, very early physicists may not have yet understood that gravity is the geometry of space time. It was reasonable, as a working assumption, to assign a Compton wavelength to gravitational 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. Also, 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 approximate number of protons in the universe. Perhaps they couldn’t compare cellular scale space to large space because they lacked information.

Cellular expansion model



PE expansion= $\int F dR$
 KE= $mv^2/2$

The initial tangential velocity is associated with a proton moving in an orbital fashion (this is idealized since kinetic energy is in the form of temperature as discussed below). Velocity is tangential because we are dealing with surfaces. The proton has kinetic energy from its fall from 19.3 MeV of potential energy. The initial condition is identical to the proposed source of gravity above, i.e. it has 9.8 MeV of kinetic energy. The derivation below is based on G remaining constant (small g below stands for the relativistic term gamma). It shows that kinetic energy decreases as the radius increases.

G remains constant $G=rv^2/(M)$		
$RV^2/(M/g)=rv^2/(M/g_0)$	$RV^2/M=rv^2$	10.11 ke
$RV^2*g=rv^2*g_0$	$RV^2=rv^2$	↓
$(v/V)^2=(r/R)*g_0/g$	$(v/V)^2=(r/R)$	
$(v/V)=(r/R)^.5*(g_0/g)^.5$		
ke=ke0*(r/R)	Ke decreases with r	

Although decreasing kinetic energy maintains G constant, gravity itself is established at the quantum scale. Expansion is outward, characterized by time and consistent with kinetic and potential energy changes. Expansion equations are derived below and agree with WMAP [5]. A filled sphere where volume V is proportional to R^3 and equal to volume V proportional to $\exp(180)*r^3$. This makes $R=r*\exp(60)$ the equation for determining large R from cell radius r.

Predictions of the cellular expansion model

Inflation

Inflation in the proposed expansion model is duplication of cells. Post inflation the radius of the universe would be $8.4e12$ meters ($\exp(60)*7.22e-14$ meters). Since the physics of each cell is identical, the horizon imposed by the speed of light is not meaningful. This could explain observations indicating uniformity (the cosmological principle and temperature uniformity).

Expansion equations

G remains constant $G=rv^2/(M)$		
$RV^2/(M/g)=rv^2/(M/g_0)$	$RV^2/M=rv^2$	10.11 ke
$RV^2*g=rv^2*g_0$	$RV^2=rv^2$	↓
$(v/V)^2=(r/R)*g_0/g$	$(v/V)^2=(r/R)$	
$(v/V)=(r/R)^.5*(g_0/g)^.5$		
ke=ke0*(r/R)	Ke decreases with r	

Nomenclature

(all calculations are MKS)

t-time

g=dimensionless time=time/alpha time

Lower case r is a cell radius

Upper case R=r*exp(60)

R1 radius is first expansion component

R3 radius is second expansion component

H3 is Hubble's constant for R3

First expansion component; R1

$(r/r_0)^3$ increases as $(t/\alpha)^2$ (kinetic energy requirement)

$$r=r_0 \cdot g^{(2/3)}$$

$$R=r_0 \cdot \exp(60) \cdot g^{(2/3)}$$

$$r_0=1.93e-13/(2.723 \cdot 2.723)^{.5}=7.22e-14 \text{ m}$$

$$R1=(7.22e-14 \cdot \exp(60)) \cdot g^{(2/3)}$$

Second expansion component: R3

$$dr/(r \cdot dt)=H3$$

$$dr=H3 \cdot r \cdot dt$$

$$dr=H3 \cdot \alpha \cdot r \cdot dg \quad (dt=\alpha dg)$$

$$dr=H3 \cdot \alpha \cdot r_0 \cdot g^{(2/3)} \cdot dg$$

$$r=H3 \cdot \alpha \cdot r_0 \cdot g^{(5/3)}/1.6666$$

$$R3=H3 \cdot \alpha \cdot (7.35e-14 \cdot \exp(60)) \cdot g^{(5/3)}/1.666$$

$$r1+r3=(7.22e-14) \cdot g^{(2/3)}+(7.22e-14) \cdot g^{(5/3)} \cdot H1 \cdot \alpha /1.666$$

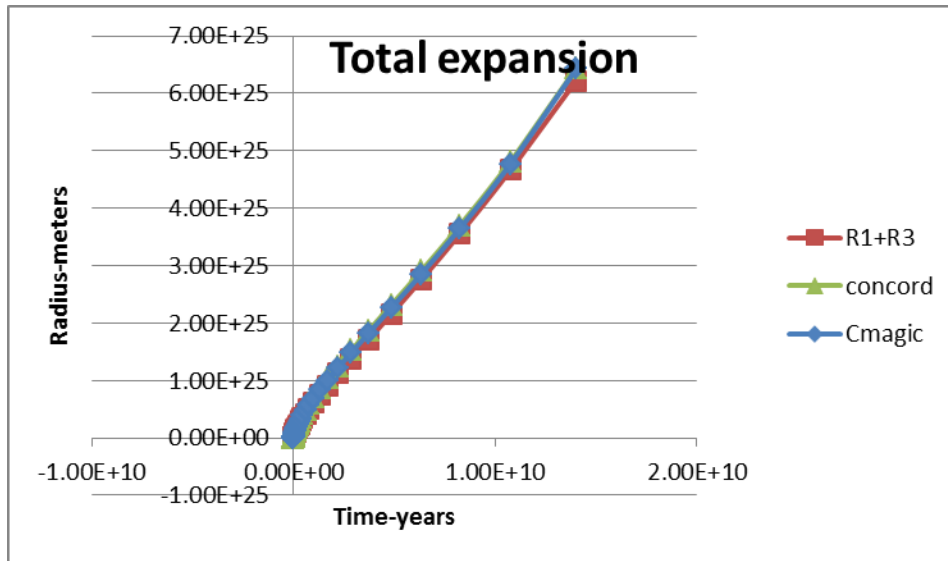
$$R1+R3=r1 \cdot \exp(60)+r3 \cdot \exp(60)$$

$$t=\alpha \cdot (R1/7.22e-14)^{(3/2)}$$

$$(R1/7.22e-14)^{(3/2)}=g=t/\alpha$$

Alpha and H1 are evaluated to fit WMAP data. Alpha=0.0529 seconds and H1=3.1e-18/sec.

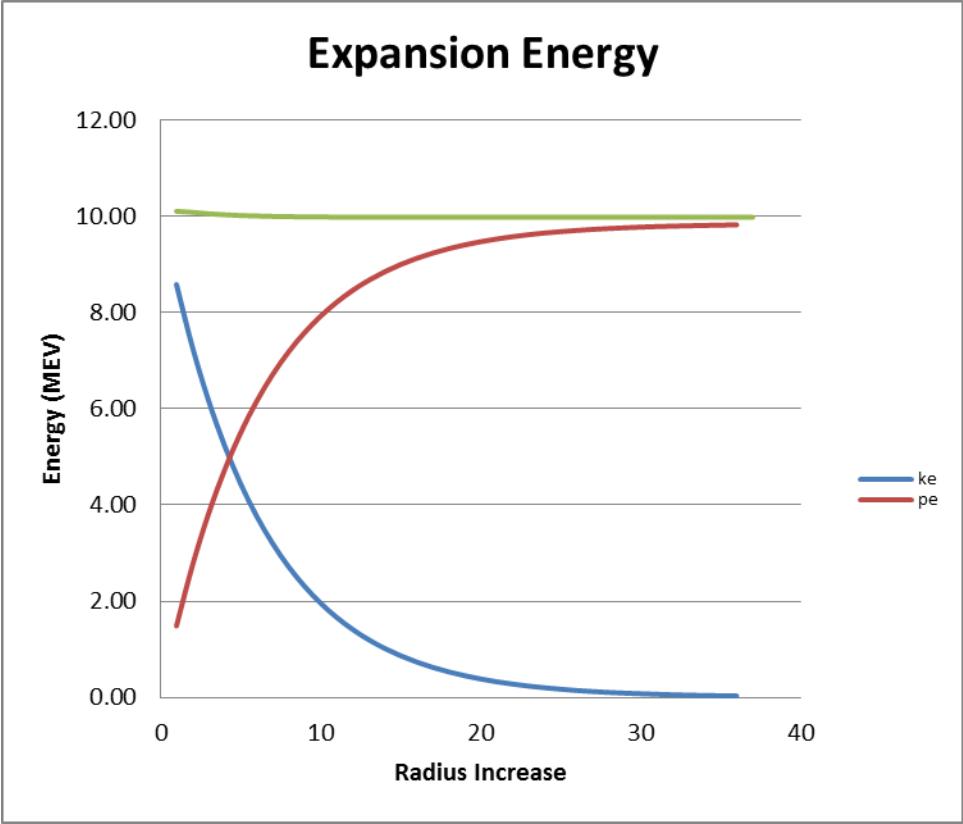
Fundamental time based on the proposed gravitational radius is 1.54e-21 sec. Expansion equations depend on dimensionless time and progress from g=1 to 8.2e18. Time =1.54e-21 sec*exp(N) sec where N starts at 45 and progresses. Dimensionless time g =time/0.0583. Incremental calculations are shown, ending with Hubble's constant H=2.26e-18/sec [12].



Expansion energy

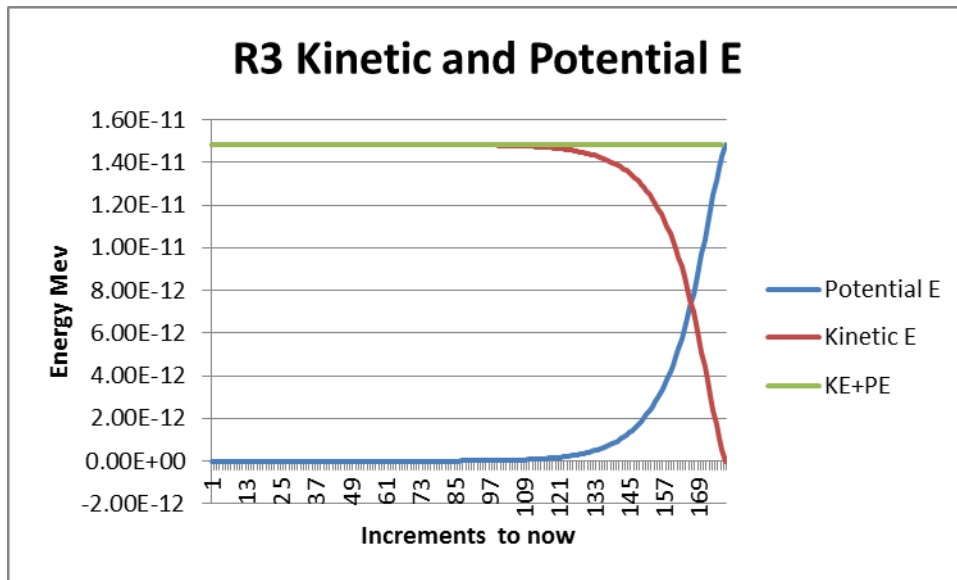
Since the expansion history is known [5][6], kinetic and potential energy can be evaluated for an expanding cell. With $7.22e-14$ meters as the initial cell radius and the tangential velocity decreasing, the inertial force can be calculated for each time increment. As the cell expands the

force $F = mV^2/r * 1/exp(90) = 3.66e-38$ NT changes and the potential energy can be determined. Incremental calculations give potential energy (integral of Fdr). Calculation of kinetic energy at the beginning isn't feasible (at least not with relationship containing V) with universe size space because the velocity is greater than the speed of light; hence the wisdom of using a cellular model. Detailed calculations of cellular kinetic energy changes show that 10.11 MeV of kinetic energy is just enough energy for one half of the protons to achieve $6.2e25$ meters radius and that kinetic energy for these protons is just converted to potential energy with the total conserved. Why one half? The resisting force F (starting with $3.66e-38$ NT) is based on each of all $exp(180)$ masses. Details presented in reference 3 suggest that protons (baryons) make up one half of the total mass. This is evidence that the other half of the mass is gravitationally active cold dark matter with mass $1.67e-27$ kg and its own energy source (a mirror of the proton perhaps). Changes in energy are plotted below (the horizontal axis units are increments of time and they quickly saturate).



Dark energy

The second component (R3 in this proposal) is late stage expansion and causes the apparent acceleration observed [6]. Calculations for potential energy required by second expansion component yields the value 1.5×10^{-11} MeV because late stage expansion is resisted by small forces. (Stated the other way, when the radius is low forces are high but delta radius is low). The value 1.5×10^{-11} MeV is a small portion of 10.11 MeV and is negligible. One can make a strong case against dark energy based on these results.



The traditional derivation $(v/r)^2 = 8/3 \pi G \rho C$ where ρC is critical density is based on initial kinetic energy being converted to potential energy as expansion occurs and the assumption that density characterizes the energy.

The equation $H = V/R = (4/3 \pi G \rho C)^{.5}$ incorrectly assumes that the second component of expansion consumes a large amount of kinetic energy. Critical density $9.5e-27 \text{ kg/m}^3$ should not be used to calculate cosmological parameters for the second component but critical density [12] for expansion can be calculated by removing dark energy. The lowered density is $9.5e-27 \text{ kg/m}^3 * (1 - 0.718) = 2.7 \text{ kg/m}^3$. Total mass/ m^3 at the end of the author's expansion curves $= 1.67e-27 * \exp(180) / (\text{Vol}) = 2.47e-27 \text{ kg/m}^3$ with $\text{Vol} = 4/3 \pi * 6.2e25^3$. Based on only 10.11 MeV of kinetic energy being available for expansion, the proton density is one half the lowered critical density and cold dark matter is the other one half. Implications are further discussed in Ref. [3].

Current kinetic energy per proton

Each cell (small r) is now about 0.54 meters and large $R = 0.54 * \exp(60) = 6.24e25$ meters. The initial $\text{KE} = 9.8 \text{ MeV}$ has diminished by the ratio of current radius to initial radius $(0.54 / 7.22e-14 = 7.45e12)$ and is now $10.11 / 7.45e12 = 1.3e-12 \text{ MeV/proton}$. This kinetic energy is associated with a proton surface velocity of 16 meters/sec.

What type of kinetic energy decreases?

Very early in expansion, plasma exists and we should not expect a neat orbit with kinetic energy 9.8 MeV. Using the Boltzmann constant, temperature can be assigned to kinetic energy as follows:

KE temperature relationship		Beginning	Current expansion state
ke=1.5 B T		9.80 mev	1.55E-12
T=ke/(1.5 B)		7.58E+10 K	0.012018048 K
Boltzmann B	8.61952E-11 mev/K		

The temperature 7.6e10 K is reasonable although this model starts with a higher density than other expansion models. Cosmologists use the expansion ratio z to scale temperatures, i.e. $T(K)=2.725*z$. However, starting with 7.6e10 K and scaling downward gives the surprising present temperature 0.012 K. Isn't the present temperature 2.725 K? Recall that about 23% of all He4 is produced in the first few minutes. This releases $7.07*0.23=1.63$ MeV. When this energy is added to the photon related energy, the temperature curve jogs upward to the accepted $2.725*z$ curve. This is important because temperature affects the radius at equality and decoupling but these occur well after the curves are identical.

Gravitational range

Since the four interactions have similar form, each with a radius based on 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.

One way to evaluate this might be the Heisenberg uncertainty principle ($\Delta x \Delta p$ proportional to $\Delta x \Delta p$, where Δx is the distance scale and Δp is the momentum scale or $\Delta E \Delta t$ is the energy scale and Δt is the time scale). If the value $1/\exp(90)$ is applied to the momentum scale, Δx would be multiplied by $\exp(90)$ and gravity would be long range. The author tried to determine which of the variables Δx , Δp , ΔE or Δt should be changed by $\exp(90)$. Dividing Δx makes the most sense and this is based on the surface replacement small r =large $R/\exp(90)$ described in the heading "Scaling Cellular Gravitation Values to Large Scale Gravitation". Choices give interesting results, i.e. $7.22e-14*\exp(90)=7.98e25$ meters and $1.5e-21 \text{ sec}*\exp(90)$ is about 60 billion years.

What about $G=(\hbar C/m^2)$?

Should the foundational relationship $G=(\hbar C/m^2)$ be preserved? In the author's opinion it would require the correction $G=(\hbar C*\exp(90)/m^2)$. G would be associated with a mass close to the proton (350 MeV) but this difference from the proton (938.27 MeV) makes one suspicious of the relationship altogether.

Examples using the value $1/\exp(90)$ to scale cell values to large size observations

Example 1: The earth's gravitation

		large space		cell size at current expansion	
R is the earth size geodesic		RV^2/M	$G=G$	r^2/m	r is the cell radius
R' is the universe size geodesic		$R'V'^2/M$	$G=G$	$r'V'^2/m$	r' is the cell size geodesic
		$R'=r*(\sqrt{V})^2*(M/m)^{1/exp(90)}$			
	R' geodesic (meters)	6.40E+06		0.547	r is the cell size geodesic (m)
	Velocity of orbit (m/sec)	7897.71		15.78	meters/sec
	Earth mass kg	5.98E+24		1.67E-27	kg
	nt m^2/kg^2	6.67E-11	$G=G$	6.67E-11	

The table above indicates that the surface of the earth must be moving at 7898 m/sec to be on the geodesic; however rotation only gives the surface 464 m/sec. Since the velocity is low we experience acceleration of 9.8 m/sec^2 .

	Mass kg (earth)	5.98E+24	
	earth R (m)	6378100	
$a=gm/r^2$	m/sec^2	9.80	

Of course, to reach a force balance one would increase velocity to the geodesic value.

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Example 2: The geodesic is universe size when expanded proton positions regain kinetic energy by falling into deep orbits.

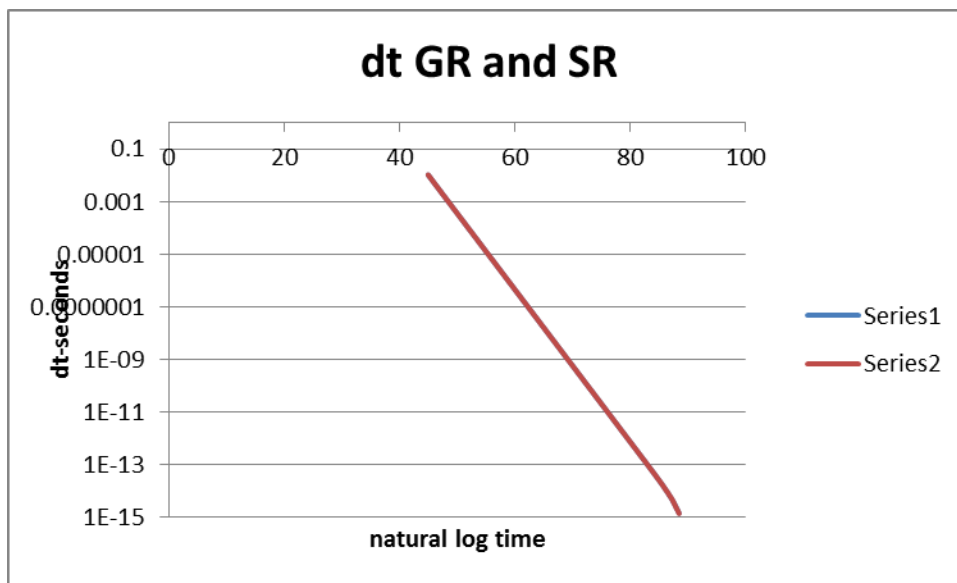
First review how orbits are formed. The diagram below shows that there was about 20 MeV of potential energy (Appendix 1 and reference 1) available (a) and the proposed model for expansion is based on an orbiting proton with approximately 10 MeV of kinetic energy (b). Since the proton is attracted to and separated from the center of the field, there was also 10 MeV of potential energy when the orbit is established. As expansion occurred (process (b)→(c) below), 10 MeV of kinetic energy was converted to 10 additional MeV of potential energy. At a much later point in expansion (c), although there is motion (temperature) of the proton on the surface of the expanding cell, there is no motion between cells (protons) except for expansion. With the proton velocity nil between cells geodesics will be extremely flat (on the order of $5e38m$) compared to $6.24e25m$. This causes acceleration of particles toward one another (process 2 below) and external kinetic energy (between protons) increases as protons fall back toward the geodesic (d)→(c). On average the expanded cells do not change their radius. Theoretically, 10 MeV of external potential energy could be reconverted to 10 MeV of kinetic energy as particles fall toward one another. Overall, process (b)→(c)→(d)→(e) converts cellular surface kinetic energy to external potential energy between cells.

shift = 1 - gamma, but since KE is low the time shift is approximately $KE/(2 \cdot 938) = 1.33e-15$ seconds.

The Schwarzschild time shift is a key general relativity prediction. The time shift calculated below is for one cell undergoing expansion at a radius of 0.54 meters. Agreement (the factor of 2 is Schwarzschild 2 in $2GM/(C^2 \cdot R)$) indicates that special relativity and general relativity make the same prediction when the large factor $\exp(90)$ is included.

$dt = 1 / (1 - 2GM / (C^2 \cdot R))^{0.5}$			
$dt = 1 / ((1 - \exp(90)^2 \cdot 6.67e-11 \cdot 1.67e-27 / (3e8^2 \cdot 0.55)))^{0.5}$			
		$dt = (\text{expression above} - 1) / 2$	
1.000000000000000133		1.332E-15 sec	

Calculations show that time dilation dt for GR and SR are equal throughout expansion. Dt for a cell starts at 0.01 sec and decreases to the present value of 1.33e-15 seconds.



Example 3: Agreement with the Schwarzschild radius.

It is demonstrated below that scaling with $1/\exp(90)$ exactly matches the Schwarzschild radius (S) calculation. Proton mass rather than Compton mass is used in the S equation below. The equation for S is:

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

$$2 \cdot (\text{Metric}) \cdot r = 1$$

$$r = 2 \cdot (\text{Metric})$$

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

$$S=2G M/C^2 \quad \text{singularity radius}$$

This equation is twice the Compton wavelength $r=G M/C^2$. With $G=r C^2/M$ this is the same equation in the box below $G=RV^2/M$ when $V=C$.

Note that in this case, the velocity at the surface is the speed of light.

Scaling a cell using 1/exp(90) gives Schwartzchild's S					
R' is the universe size geodesic		R'V^2/M	G=G	r'v^2/m	r' is the cell size geodesic
	M=m*exp(0)	1.67E-27		1.67E-27	kg
R'=(v/V)^2*(M/m)*1/exp(90)	R	1.238E-54		0.547	r'
	V (meters/sec)	3.00E+08		15.78	v (meters/sec)
	G	6.67E-11		6.67E-11	nt m^2/kg^2

R above equals 1.24e-54 meters. And below, the same calculation from Schwarzschild $S=GM/C^2=2.48e-54$ meters.

m	1.67e-27 kg
S=GM/C^2	2.48E-54
S/2	1.24E-54

For one solar mass in universe sized space. In these calculations, big $V=C$ and the result is the Schwarzschild radius (S) for the solar mass (2e30kg). The result is $S=1.48e3$ meters. The $G=G$ scaling procedure with 1/exp(90) used as a multiplier for the expanded cell matches the accepted Schwarzschild result (1.5e3 meters).

	m	
$S=2GM/C^2$		2.96E+03
My Geodesic at C and High M		1.50E+03
$S=2\text{Geodesic}$		3.00E+03

Conclusions

The author used an information-based approach to identify basic energy components and constructed an energy model of the proton comprised of these components. Information was extracted from the model that appears to unify interactions. A new quantum scale source for the gravitational constant was proposed that agrees with general relativity and extends our understanding of gravity. It was also shown that the low coupling constant for gravity is the small value 1/exp(90). Although the focus of this paper was gravitation, a hierarchy of fundamental interactions was reviewed.

With a better understanding of gravity and knowledge from WMAP regarding the approximate number of proton masses, results from a cellular model of expansion have been presented. Fundamentals were presented that relate low scale values to large scale observables. The cellular approach avoids calculation on the large scale when expansion velocity is super-luminal. As one would suspect, kinetic energy conversion to potential energy indicates overall energy

conservation. The initial kinetic energy 9.8 MeV/proton is enough energy to expand each proton to $6.24e25$ meters but if all $\exp(180)$ particles were protons, it would be only one half the required energy. The basis of this conclusion is that all $\exp(180)$ proton like masses contribute to the resisting gravitational force. This suggests that the other half may be gravitationally active cold dark mass. Kinetic and potential energy calculations have implications for the ongoing dark energy search. It appears that the second (accelerating) component of expansion requires minimal energy. The implied cosmological fractions are $\omega_{\text{dark}}=0$, $\omega_{\text{baryon}}=0.5$ and $\omega_{\text{cold dark matter}}=0.5$.

Examples were presented utilizing the small factor $1/\exp(90)$ at the cellular scale. Calculations show that special relativity time dilation is equal to Schwarzschild general relativity time dilation throughout expansion when the factor $1/\exp(90)$ is used. The purpose of this was to show that a low energy scale gravitational scale works and perhaps replaces current fundamentals.

It is the author's view that the radius and time associated with field energy 2.732 MeV and the associated expansion curves define space and time.

Appendix 1

Neutron and Proton mass models

The proton is thought to be a primary manifestation of the underlying laws and as such contains information that determines many aspects of nature. The Proton Mass model is the source of constants for unification of forces in the table above. The full model is shown below. It is based on interaction explained in Reference 13.

		Residual ke		Gravitational Field	
Mass	Difference	KE	Expansion		Strong field
mev	mev	mev	mev	KE	MeV MeV
101.95	641.88				-753.29
					-0.69
13.80	78.69				-101.95
					-0.69
13.80	78.69				-101.95
					-0.69
		10.15		20.30 expansion pe	
				0.00 expansion ke	
	-0.67		0.67 v neutrino		
			0.05 neutrinos		-0.67
129.54	798.58	938.27	PROTON MASS		
0.51	0.11	e ke			
ELECTRON					
			Total m+ke		Total Negative
	0.62	938.27	0.72	959.92	-959.92
			MeV	MeV	-2.73

The proton mass is easier to understand if we add the quark masses together and the quark kinetic energies together as shown below:

	MeV	MeV	MeV	MeV
Quark S	101.947	641.880	-753.291	-0.687
Quark U	13.797	78.685	-101.947	-0.687
Quark D	13.797	78.685	-101.947	-0.687
	129.541	799.251	-957.185	-2.061

The exact proton mass results after a neutrino of 0.671 MeV is ejected and the Strong Residual kinetic energy 10.15 MeV is added as shown below:

	129.541	799.251	-0.671
		10.151	
Proton		938.272	Mev

The full proton model is shown above followed by consolidations required to create a simpler model. They total 129.541 MeV. The three quarks are imbedded in a strong field labelled -

957.185 and a gravitational field energy labelled -2.732 MeV. The total field energy for the entire table is -959.92 MeV. This is lower than the known Neutron mass 939.565 MeV and the “missing energy” is a potential energy field -20.3 MeV. The quarks with their kinetic energy fall into the field and gain 10.15 MeV from their fall. The neutron subsequently falls to a radius $7.22e-14$ meters. It originally had kinetic energy 20.3 MeV but when the gravitational orbit was established, the ke was about 10 and the potential energy was about 10. The neutron plus its associated gravitational energy balances the total table energy 959.92 MeV. The neutron decays into a proton, an electron and a neutrino. This gives the measured proton mass 938.27 MeV below. As the proton and electron split they develop opposite fields of $27.2e-6$ Mev. When the electron falls into the proton field it develops $13.6e-6$ Mev.

Mass and Kinetic Energy			Field energy	
Mass	KE	Strong Residual	Strong field energy	Gravitational Energy
MeV	MeV		MeV	MeV
Strong	130.16	799.25	-957.18	-2.73
Strong Residual		10.15		
Neutron		939.57	-20.30	-959.92
below, the Neutron decays to a proton, electron and neutrino				
neutrinos		0.05		
Proton		938.27	2.72E-05	
ejected neutrino		0.67	E/M charge splits	
Electron	0.51	0.11	-2.72E-05	
Gravitational ke		10.15	10.11	
Gravitational pe		10.15	10.19	
Total		959.92		

Information from the proton mass model is used to understand fundamental interactions. Some may notice that the quark masses are higher than the accepted values associated with down and up quarks. The author believes based on reference 10 that quarks can transition to lower energy, converting some of their mass to kinetic energy but conserving mass plus kinetic energy. This process is observed in mesons and baryons as they decay.

Values extracted from the model are important for fundamental interactions.

Coupling constants quoted in the literature are for protons and this allowed direct comparison.

Appendix 2

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 9.9 MeV/proton [1][2] and the value above compare favorably.

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