Exploration

On the Source of the Gravitational Constant at the Low Energy Scale

Gene H. Barbee*

ABSTRACT

In general relativity, gravity is attributed to the geometry of space-time. Further, it is assumed that the gravitational constant (G) originate from the Planck scale. The Compton wavelength (Planck length) L=(\h*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 said that the Compton wavelength is nature's response to geometry and mass at the quantum scale. In this paper, I will discuss 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). The approach I use to model expansion is a cellular approach. A cell is the space associated with each proton and has cosmological properties that allow it to represent the universe geometrically. Each cell has an initial radius of 7.34e-14 meters and, if it expands according to WMAP history, its current value is 0.55 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:

$$\alpha_G = Gm_e\text{^}2/(hC)=(m_e\text{^}2/m_p\text{^}2)=1.752e\text{-}45$$

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; ħ is the reduced Planck constant; m_p is the Planck mass.

*Correspondence: Gene H. Barbee, Independent Researcher. Email: genebarbee@msn.com

This coupling constant can be understood as follows:

http://en.wikipedia.org/wiki/Gravitational_coupling_constant		
	alphaG=(mp/me)^2=1.752e-45	
	mp/me=1836.15	where mp/me=proton/electron
	alphaG=1836.15^2*1.752e-45=5.907e-39	
	F=(5.9068e-39)*hC/R^2	

If R for the force calculation is 7.35e-14 meters, as proposed above, the force is:

F=(5.9068e-39)*hC/R^2				
	hbar		6.58212E-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/(7.35e-14)^2=3.39e-38 NT				
3.4527E-38	NT			

This result agrees with the simple Newtonian force:

F=Gmm/R^2 (nt)=6.67428e-11*1.6726e-27^2/7.354e-14^2		3.4524E-38

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 model is reviewed in Appendix 1. It appears that the proton is a manifestation of fundamental laws and as such contains basic information about four interactions. The following information was extracted from the proton model:

	Mass (m)	Ke	gamma (g)	R	Field (E
	(mev)	(mev)		meters	(mev)
Gravity	938.272	9.800	0.9897	**7.3543E-14**	-2.683
Electromagne	0.511	1.36E-05	0.99997	**5.2911E-11**	-2.72E-05
Strong	129.541	799.251	0.1395	**2.0928E-16**	-957.18
Strong residu	928.121	10.151	0.9892	**1.4297E-15**	-20.303

The table gives the field energy 2.683 MeV as the basis for gravitation. The proposal below indicates that this field energy is associated with a radius of 7.35e-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		2.683	mev
constant	HC/(2pi)	1.97E-13	mev-m
	R=constant/E	7.35E-14	m
	Field side	R side	
	H/E	2*pi*r/C	
time (t)	1.54E-21	1.54E-21	sec
Proposal p	(p=E/C)	8.95E-09	mev-sec/m
p*R/h		1.00	
qm test	M/C^2R^2/t	6.58E-22	mev-sec
qm test/h	M/C^2R^2/t/l	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 7.35e-14 meters we would expect an orbit to be established.

				GRAVITY
				proton
Proton Mass (mev)				938.272
Proton Mass M (kg)				1.673E-27
Field Energy E (mev)				2.683
Kinetic Energy ke (mev)				9.720
Gamma (g)=M/(M+ke)				0.9897
Velocity Ratio		v/C=(1-(g)^2)^.5		0.1428
"R equation"	**R (meters) =((HC/(2pi)/(E*E)^0.5)**			**7.3543E-14**
	F (NT)=M/g*(v/C*C)^2/R/exp(90)			3.4524E-38
HC/(2pi)	1.973E-13	mev-m		
Calculation of gravitational constant G				
Inertial Force=(M/g*C^2/R)*1/EXP(90) NT				3.4524E-38
Radius R (Meters)				7.3543E-14
Mass M (kg)				1.673E-27
Gravitational Constant (G=F*R^2/M^2=NT m^2/kg^2)				6.67428E-11
	Published by Partical Data Group (PDG)			6.67428E-11
PE fall	mev			19.34
KE orbit	mev			9.720
F (NT) =PE/R=19.34*1.603e-13/7.3543e-14/exp(90)				3.4524E-38

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 7.35e-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:

Unification Table		cell ax74		Strong strang	Strong down	Strong down	Gravity	Electromagnetic	
Higgs energy (mev)				128992.0	128992.0	128992.0	proton		Strong Residual
***Field coupling to Higgs field Energy				0.00629	0.00085	0.00085			
	Potential energy of proton falling into gravitational field (mev)						19.340		
Field Energy E (mev)				811.96	109.89	109.89	2.683	2.72172E-05	20.303
Mass Coupling to Higgs field energy				0.00085	0.00012	0.00012			
Particle Mass (mev)				109.887	14.872	14.872	938.272	0.511	928.121
Mass M (kg)				1.96E-28	2.65E-29	2.65E-29	1.6726E-27	9.11E-31	1.65E-27
Kinetic Energy (mev)				702.07	95.02	95.02	9.720	1.36086E-05	10.151
	Rydberg energy from PDG							1.360569E-05	
Gamma (g)=m/(m+ke)				0.1353	0.1353	0.1353	0.9897	0.99997	0.9892
Velocity Ratio		v/C=(1-(g)^2)^.5		0.9908	0.9908	0.9908	0.1428	0.0073	0.1467
R (meters) =((HC/(2pi)/(E*M/g)^0.5)				**2.4303E-16**	**1.7957E-15**	**1.7957E-15**	**7.3543E-14**	**5.291126E-11**	**1.4297E-15**
Electromagnetic R minus proton R=5.291627e-11-1.4297e-15								5.2910E-11	
Force	Newtons	F=E/R*1.6022e-13		535295.6	9804.3	9804.3	3.4524E-38	8.241498E-08	2275.2
Inertial F	Newtons	F=M/g*V*2/R		535295.626	9804.281	9804.281	3.4524E-38	8.241389E-08	2262.86246
Force=3.16e-26/Range^2 (nt)				535295.6	9804.3	9804.3		1.129E-05	15466.9
HC/(2pi)	3.16E-26	(4.13e-21*3e8*6.24e12/(2*pi())							
	F=(5.907e-39)*hC/R^2 (nt)						3.4527E-38		
	F=Gmm/R^2 (nt)=6.67428e-11*1.6726e-27^2/7.354e-14^2						3.4524E-38		
Coupling constant derived from this work				1.0000	1.0000	1.0000	1/exp(90)	137.030687	0.147099
Derived c^2 (E*R) mev m				1.97E-13	1.97E-13	1.97E-13	1.17E-51	1.44E-15	2.90E-14
Derived c^2 joule m				3.16E-26	3.16E-26	3.16E-26	1.87E-64	2.31E-28	4.65E-27
Derived exchange boson (mev)				811.960	109.887	109.887	2.683E+00	0.0037	138.02
*published c^2 mev m							1.17E-51	1.44E-15	1.56E-14
*published c^2 joule m							1.87E-64	2.31E-28	2.5E-27
*Range	Range for gravity equals		8.98E+25	meters				5.29E-11	
*http://www.lbl.gov/abc/wallchart/chapters/04/1.html									
Published coupling constant (PDG)								137.03599	
***	0.0063	EXP(17.432)/EXP(22.5)							
***	0.00085	EXP(15.432)/EXP(22.5)							
***	0.00012	EXP(13.432)/EXP(22.5)						2.72121E-05	

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=hC/R^2= 15467 NT requires the coupling constant 0.147 and the derived c^2= 2.9e-14 MeV m is similar to the published value 1.56e-14 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 MeV+10.151 MeV =938.272 MeV).

A possible candidate for gravitational energy scale

Nomenclature and review

	Constants			
\h	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		
	Relationships			
	Compton wavelength=GM/C^2			
	GM/C^2	6.67e-11*2.18e-8/3e8^2		
	L=GM/C^2		1.62E-35	meters
	L=Ch/E=h/MC		1.62E-35	meters
	L=h/MC=GM/c^2		1.61E-35	meters
	G=hC/M^2			

First compare the quantum mechanical action at two levels, the Planck scale and the much lower level (2.683 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=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

The proton mass (1.67e-27 kg) is analogous to the Compton mass, i.e. proposed mass is 938.27 MeV, not 1.22e22 MeV (1.67e-27 kg, not 2.17e-8 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 2.18e-8 kg

G=hC/M^2
G=(6.58e-22*3e8/(2.18e-8)^2*1.603e-13)
6.66E-11 nt m^2/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 nt m^2/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. *At a particular time in expansion*, we will evaluate the gravitational constant G of a large sphere and compare it with G of many small cells.

Area=4 pi R^2
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) surface area substitution
M=m*exp(180) 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 particular time in expansion:
Large space Cellular space

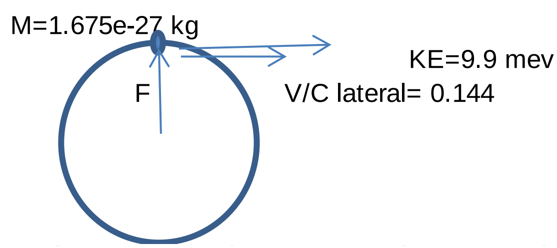
		with substitutions
RV^2/M=	G=G	r*exp(90) *v^2/(m*exp(180))
		(rv^2/m)/exp(90)

This is the source of 1/exp(90). When measurements are made at the large scale as must 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=integral 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).

RV^2/(M/g) G=G rv^2/(M/g0)
But the universe expands and r=7.35e-14 meters is scaled up by time^(2/3)
R space becomes r*time^(2/3)
what happens to v^2 so that G=rv^2/M remains constant when r expands?

RV^2/(M/g)=rv^2/(M/g0)	RV^2/M=rv^2/m	9.75 ke	ke=.5 (m/g)v^2
RV^2*g=rv^2*g0	RV^2=rv^2		ke0=.5 (m/g0)V^2
(v/V)^2=(r/R)*g0/g	(v/V)^2=(r/R)	velocity falls	ke/ke0=(m/g)v^2/((m/g0)V^2)=r/R
(v/V)=(r/R)^.5*(g0/g)^.5		0	ke/ke0=(g0/g)(v/V)^2
			ke=ke0*(g0/g)(r/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)*7.35e-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

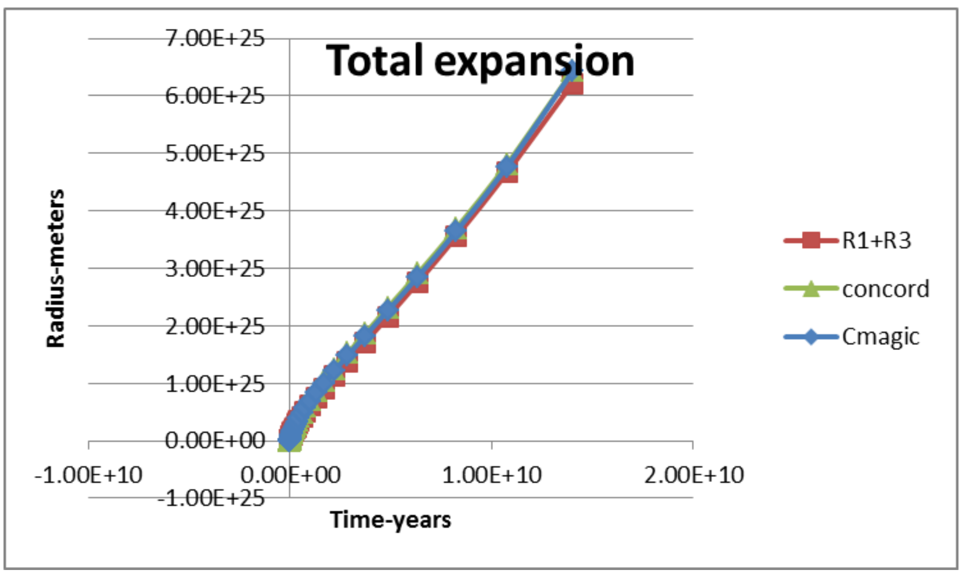
Nomenclature

(all calculations are MKS)
v-velocity (m/sec)
M-mass (kg)
R-radius (meters or m)
G-gravitational constant (nt m^2/kg^2)
c-constant of integration
dt-delta time
t-time
g=dimensionless time=time/alpha time
lower case r is a cell radius
H1 is Hubble's constant for R3
R1 radius is first expansion component
R3 radius is second expansion component
Rt=R1+R3

integral dR has two components
int dR=Rt-R1
Rt=R1+int dR
Rt=R1+R3
R=f(t)=f(g)
first component;
r^3 increases as g^2 (will be g^(2/3) in next step)
R^3=(r)^3*g^2*exp(180)
R=r*g^(2/3)*exp(60)
r=1.93e-13/(2.683*2.683)^.5=7.35e-14
R1=(7.35e-14)*t^(2/3)*exp(60)
second component:
dr=H1*r*dt
dr=H1*alpha*r *dg (dt=alpha dg)
evaluate integral dr
r3=int (7.35e-14)*g^(2/3)*dg*H1*alpha =(7.35e-14)*g^(5/3)*H1*alpha/1.666
r1+r3=(7.35e-14)*g^(2/3)+(7.35e-14)*g^(5/3)*H1*alpha/1.666
R1+R3=r1*exp(60)+r3*exp(60)

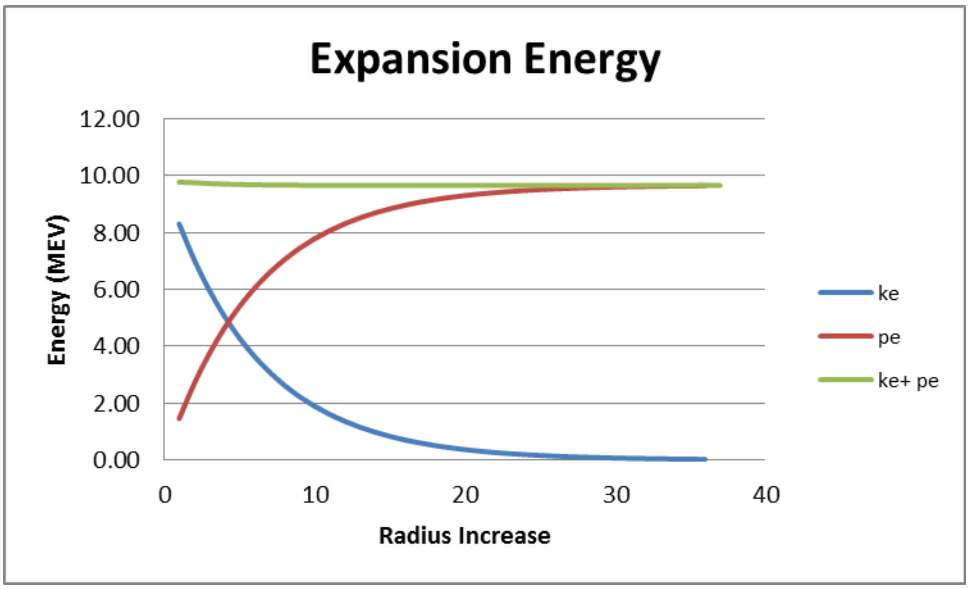
Alpha and H1 are evaluated to fit WMAP *data*. Alpha=0.0583 seconds and H1=3.1e-18/sec.

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].



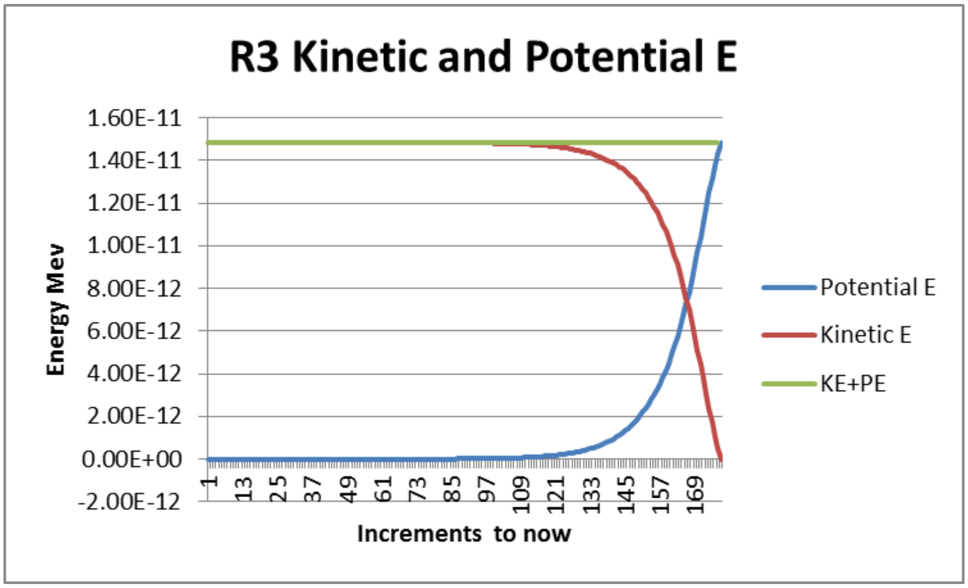
Expansion energy

Since the expansion history is known [5][6], kinetic and potential energy can be evaluated for an expanding cell. With 7.35e-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)=3.452e-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 9.8 MeV of kinetic energy is just enough energy for one half of the protons to achieve 6.24e25 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 3.45e-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 1.5e-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 1.5e-11 MeV is a small portion of 9.8 MeV and is negligible. One cannot make a case for dark energy based on these results.



The traditional derivation (v/r)^2=8/3 pi G rhoC where rhoC 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*rhoC)^.5 incorrectly assumes that the second component of expansion consumes a large amount of kinetic energy. Critical density 9.5e-27 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 kg/m^3*(1-0.718)=2.7 kg/m^3. Total mass/m^3 at the end of the author's expansion curves =1.67e-27*exp(180)/(Vol)=2.47e-27 kg/m^3 with Vol=4/3*pi()*6.24e25^3. Based on only 9.8 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 0.55 meters and large R=0.55*exp(60)=6.24e25 meters. The initial KE=9.8 MeV has diminished by the ratio of current radius to initial radius (0.55/7.35e-14=7.45e12) and is now 9.8/7.45e12 =1.3e-12 MeV/proton. This kinetic energy is associated with a proton surface velocity of 15.8 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 de-coupling 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 (dh proportional to dx*dp, where dx is the distance scale and dp is the momentum scale or de is the energy scale and dt is the time scale). If the value 1/exp(90) is applied to the momentum scale, dx would be multiplied by exp(90) and gravity would be long range. The author tried to determine which of the variables dx, dp, de or dt should be changed by exp(90). Dividing dx 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. 7.35e-14*exp(90)=7.98e25 meters and 1.5e-21 sec*exp(90) is about 60 billion years.

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

Should the foundational relationship G=(\h C/m^2) be preserved? In the author's opinion it would require the correction G=(\h 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	rv^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*(v/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.

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 to10 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.

		Process 1		Process 2	
		Internal Kinetic Energy (MEV)	Potential Energy (MEV)	External Potential Energy (MEV)	
a	Start	0	20		
		↓	↓		
b	Orbit	10	10	10 Orbit with 10 MEV KE	e
↓	Expansion	↓	↓	↑ Fall back to geodesic	↑
c	Expanded	0	20	20 Expanded condition	d

What actually happened during expansion was a transition occurred and acoustic waves broke the total mass into about 27000 clusters. After equality of photon density and mass density, process (d)→(e) occurred, protons accumulated and eventually fell into orbits that we observe as clusters of galaxies, galaxies, etc.

During expansion, the kinetic energy of the proton on the cell surface decreased by KE/ke =9.8/ 7.4e12=1.3e-12 Mev and the current velocity on the surface of each cell fell to15.8 m/sec.

The protons could theoretically regain 4.3e7 m/sec by falling but particles usually fall less than this where orbits are established. The scaling procedure using 1/exp(90) yields R=9e25 meter.

		Scaling a cell to universe sized space at KE=9.8 MEV (V=4.3e7 m/sec)						
R' is the universe size geodesic			R'V'^2/M	G=G	r'v'^2/m	r' is the cell size geodesic		
			m=1.67e-27 kg					
		M=m*exp(180)	2.49E+51		1.67E-27	kg		
R'=r*('v/V)^2*(M/m)*1/exp(90)		R	8.998E+25		0.547	r'	6.25E+25	meters
		V (meters/sec)	4.30E+07		15.78	v (meters/sec)		
		G	6.67E-11		6.67E-11	nt m^2/kg^2		

The original energy/particle is conserved and agrees substantially with Kauffmann (Appendix 2) [3].

As an engineer one cannot help but be impressed with the approximate energy conservation of combined processes 1 and 2. These processes represent the largest construction project in nature and almost no energy is consumed. The "neat trick" seems to be cells that expand, on average don't re-contract and are able to move and fall relative to each other after they are far apart.

The radius 9e25 meters is larger than R1+R3=6.24e25 meters. The equations for expansion cause this difference. Although gravitation is based on the mass of exp(180) protons, this may be a combination of protons and cold dark matter.

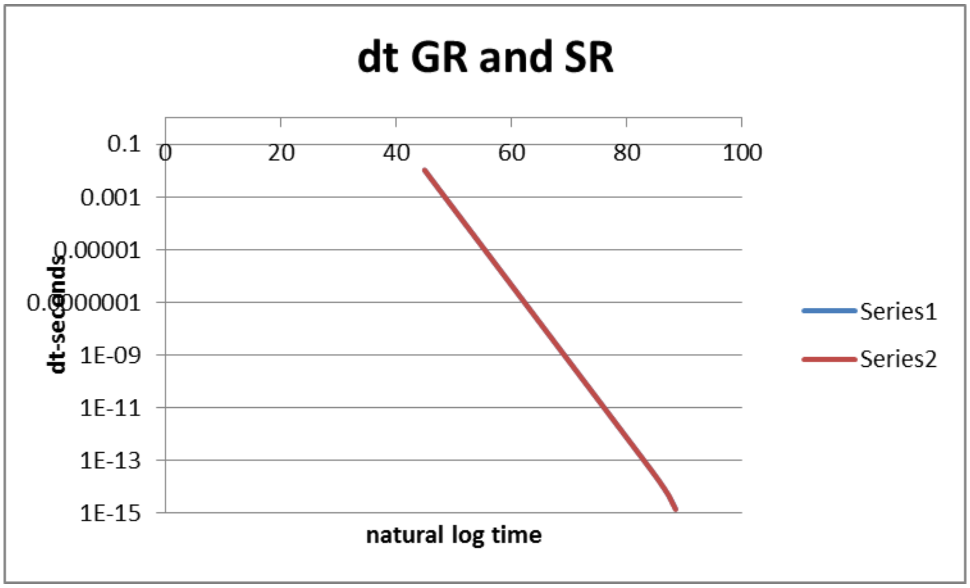
Time dilation

An expanded cell with a surface velocity of 15.8 m/sec gives a special relativistic time shift of 1.33e-15 seconds (calculated from velocity, KE=1.3e-12 MeV, gamma=(938/(938+KE), time shift =1-gamma, but since KE is low the time shift is approximately KE/(2*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 0.55 meters. Agreement (the factor of 2 is Schwarzschild 2 in 2GM/(C^2*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*R)^.5				
dt=1/((1-EXP(90)*2*6.67e-11*1.67e-27/(3e8^2*0.55)))^0.5				
		dt=(expression above-1)/2		
1.00000000000000133		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 in used in the S equation below. The equation for S is:

1=1/(2*(Metric)-r)	term in solution
2*(Metric)-r=1	
r=2*(Metric)	
Metric=G M/C^2	M is mass
S=2G M/C^2	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'=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=2Geodesic	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 dark=0, omega baryon=0.5 and omega 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 2.683 MeV and the associated expansion curves define space and time.

Appendix 1

Information from the proton mass model below is used to understand fundamental interactions. The energy values in the box add to the exact mass of the proton (938.2703 MeV). There are three main components, each with a mass and kinetic energy. The total mass and kinetic energy on the left side of the box (959.56 MeV) is balanced by fields on the right hand side of the box. There is 20.3 MeV of potential energy available for expansion and 10.15 MeV of kinetic energy associated with binding energy.

ell g228	CALCULATION OF PROTON MASS			Mass and Kinetic Energy					Field Energies	
mass	Energy-mev	strong field	Energy-mev	Mass	Difference ke	Strong residual ke	Neutrinos	Expansion ke	Strong & E/M	Gravitation
ke		grav field		mev	mev	mev	mev	mev	field energy	Energy
15.432	101.947	17.432	753.291	101.947	641.880				-753.29	
12.432	5.076	10.432	0.687							-0.69
13.432	13.797	15.432	101.947	13.797	78.685				-101.95	
12.432	5.076	10.432	0.687							-0.69
13.432	13.797	15.432	101.947	13.797	78.685				-101.95	
12.432	5.076	10.432	0.687							-0.69
		-0.296	-2.72E-05			10.151		20.303	expansion pe	
charge		equal and opposite charge						0.000	expansion ke	
10.408	0.67	0.075		0.000	0.000	-0.671	0.671	v neutrino		
-10.333	0									
rates here to form proton and electron				129.541	799.251	**938.272013**	**PROTON MASS**			
10.136	0.51	10.333	0.62	**0.511**	0.111				5.44E-05	-0.622
0.197	2.47E-05	0.296	2.72E-05	**ELECTRON**			2.47E-05	e neutrino		
				130.052	0.111		0.671	20.303	-957.185	-2.683
90.000		90.000				1.673E-27		Total m+ke	Total fields	
								Total positive	Total negative	
								959.868	-959.868	0.00E+00

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.

	Mass (m)	Ke	gamma (g)	R	Field (E
	(mev)	(mev)		meters	(mev)
Gravity	938.272	10.151	0.9893	**7.3543E-14**	-2.683
Electromagne	0.511	1.36E-05	0.99997	**5.2911E-11**	-2.72E-05
Strong	129.541	799.251	0.1395	**2.0928E-16**	-957.18
Strong residu	928.792	10.151	0.9892	**1.4292E-15**	-20.303

The author uses 9.7 or 9.8 MeV instead of 10.15 above. Coupling constants quoted in the literature are for protons and this allowed direct comparison. Small corrections for the mass of electrons and neutrinos bring this energy closer to 10 MeV.

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.

References

1. Barbee, Gene. H., *A Top-down Approach to Fundamental Interactions*, FQXi essay, June 2012. viXra:1307.082 revised Feb 2014.
2. Barbee, Gene H., *Application of Proton Model to Cosmology*, viXra:1307.0090, revised March 2014. Accompanying Microsoft ® spreadsheet unifying concepts.xls
3. Barbee, Gene H., *Expansion Kinetic and Potential Energy*, viXra:1307.0089, revised February 2014.
4. Kauffmann, S.K., *A Self-Gravitational Upper Bound on Localized Energy*, Including the Virtual Particles and Quantum Fields, which Yields a Passable "Dark Energy" Estimate, arXiv: 1212.046v4, 24 Mar 2013.
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.
7. Private communication with S Kauffmann.
8. Claude Shannon, *A mathematical Theory of Communication*, 1948.
9. Barbee, Gene H., *A Simple Model of Binding Energy*, viXra: 1307.0102, revised March 2014.
10. Barbee, Gene H., *Baryon and Meson Masses Based on Natural Frequency Components*, viXra:1307.0133.
11. http://www.lbl.gov/abc/wallchart/chapters/04/1.html
12. http://arxiv.org/pdf/1212.5226v3.pdf Table 2.