Kinetic and potential energy during expansion
May 30, 2013
Gene H Barbee

Abstract

Gravity is known to be the geometry of spacetime (general theory of relativity). It is generally accepted that the gravitational constant remains constant as the universe expands. This paper shows how the curvature of space and time (described by geodesics) changes to keep G constant. WMAP analysis led to expansion curves that are now generally accepted. The author's expansion curves agree with WMAP but equations that are thought to be more fundamental are developed and used. A unique cellular approach is used that allows the kinetic energy and potential energy to be accessed and compared with WMAP equations. The comparisons show that the concept of critical density (H=(8/3 pi G rhoC)^.5) is not correct. It is demonstrated that there is no missing energy (dark energy) but there is dark matter.

Expansion equations

It is generally accepted that expansion involves the conversion of kinetic energy to potential energy. The heading below entitled "Comparison and analysis of the equation H=(8/3 pi G rho)^.5" reviews the Friedmann derivation leading to the accepted relationships between expansion and time. (R is proportional to time^(2/3). The derivation below uses this relationship and the concept that the universe can be modeled by the expansion of many small spherical cells.

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	
H is Hubble's constant	
R3 radius due to cosmolgical constant	

In the derivation below Mu is the total mass and rho is density at each point in the expansion. These cancel leaving R^3 as the large variable. This result is for expansion of a small cell, labeled r that is duplicated exp(180) times to fill the overall volume. Time is defined as a time ratio called g=time/alpha time.

Mu=rho*4/3*pi()*R^3=rho*4/3*pi()*r^3 exp(180)
R^3=r^3*exp(60)^3
r^3=(k/(mE)^3*g^2=1e-14*g^2
r^3 increases as g^2 (will be time^(2/3) in next step)
R^3=(1e-14)^3*g^2*exp(180)
R=(1e-14)*g^2/3 exp(60)
v=HR
dR=HR dt (dt=alpha dg)
dR=H alpha R dg
int 1e-14 g^2/3 dg =Rf-1e14*g^2/3
Rf=1e-14*g^(2/3)+1e-14*g^(5/3)*H1 alpha/1.666

Note that a constant of integration is included in the derivation and it is evaluated with the Hubble constant H. This is Einstein's controversial cosmological constant that is now included in documents such as the WMAP and Cmagic analysis (reference 3, 5). The cosmological constant adds a term that expands with time, after integration, raised to the power (5/3). The author will use time^(2/3) and time^(5/3) for the two terms but prefers to consider the proton as a center for expanding cells. The full expansion equations are shown below in the heading "Making proton size space into universe size space".

Identifying alpha, G omega and constants in the expansion equation

Below, the gravitational field energy 2.683 mev, the fundamental mass 129.5 mev and the initial orbital kinetic energy 10.15 mev are from reference 1. For convenience, a reference 1 table is included under the heading "How nature achieves high potential energy".

Particle Mass (mev)				129.541
M (kg)				2.309E-28
Field Energy (mev)				2.683
Kinetic Energy (mev)				10.151
Gamma (g)=m/(m+ke)				0.9273
Velocity Ratio		v/C=(1-(g)^2)^.5		0.3742

Fundamental radius r=1.973e-13/(2.683*129.54/1)^.5=1.058e-14 meters.

convenient constant:	HC/(2*pi)		1.973E-13	mev-meters

Fundamental time is the time to travel around 1.058e-14 meters at a speed of V/C=0.374.

Define alpha as initial time and omega as final time. g is the ratio time/alpha (sometimes the upper case G is used below).

Identify the fundamental unit of time for expansion is the gravitational orbit described above/(time around radius)							
	Fundamental time=1.058e-14*2*PI()/(0.373*3e8)						
	Fundamental time		5.92745E-22	seconds			
Define Omega							
	Omega time is identified as fundamental time*exp(90).						now/omega
	Omega =Fund t*exp(90)		7.23388E+17	seconds	2.29E+10	years	0.58
Find alpha from WMAP							
	Alpha is an emperical constant derived from WMAP data						
		The spot size is 0.0105 radians when Runiverse =			8.817E+25	WMAP data match	
Back calculate for G at a radius of 8.758e25 meters using the equation							
	G=((2.683*129.541)/(1/(8.81e25/exp(60)/1.973e-13))^2)^(3/4)					1.973E-13	
			6.230E+20				
Calculate alpha							
	alpha= omega/G		**0.00116**	**seconds**			

Alpha was refined using WMAP data. Alpha=0.0011 seconds gave a slightly better match for WMAP spot size angle=0.0105 radians.

Find expansion constant H1:

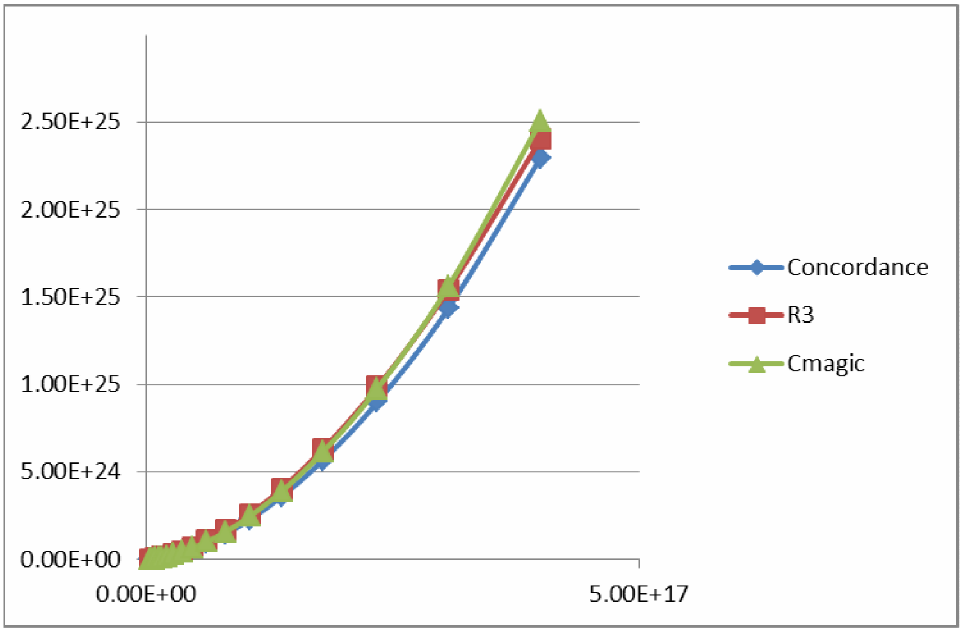
Rf=1e-14*G^(2/3)+1e-14*G^(5/3)*H1 alpha/1.666	

Call the first component of Rf (total radius), R1 and the second part R3. Note in the equation above that there are no unknowns in the equation R1=1.06e-14*G^(2/3) but the second part R3=1.06e-14*G^(5/3)*H1*alpha/1.666 contains alpha and one unknown, H1. Alpha is known but H1 must be evaluated from data. Time of expansion is alpha*G and in the range of 13 billion years, we look at H1. A “Hubble’s constant” H1 can be calculated for R1 expansion only and its value is 1.6e-18/sec. If this value is used as the unknown H1 the resulting expansion curve compares favorably with both the concordance model and the Cmagic model as shown below [1],[3]. Using these values the equation for R3 is: R3=1e-14*G^(5/3)*1.6e-18*0.0011/1.666.

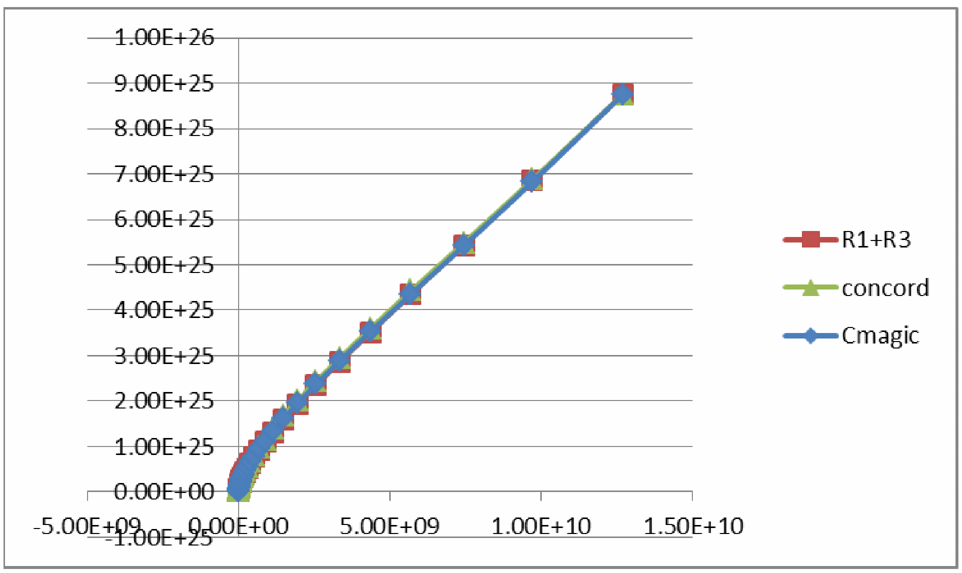
R is calculated with increasing G until overall H is 2.3e-18. The match gives R= 8.8e25 meters at 4.08e17 seconds (13.23 billion years). R3 is 0.276 of the total radius but of course expanding faster (power is 5/3).

With the above omega, it is also possible to speculate that we are at 0.58 of omega.

Expansion Comparison



With all the unknowns identified, the results can be compared with the concordance and Cmagic models.



Gravity in expanding space

Universe size space

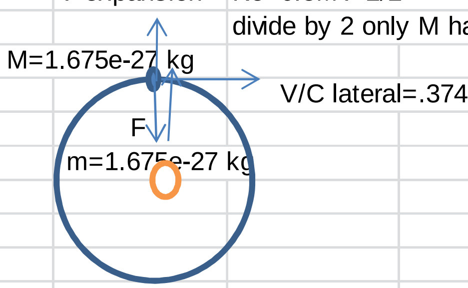
Note: G below stands for gravitational constant, not time ratio. The gravitational constant G=rV^2/M depends on r, V^2 and M, but V and r both change as the universe expands.

F=GMM/r^2		M is central mass, M orbits		
F=MV^2/r=GMM/r^2		G is the gravitational constant		
MV^2=GMM/r		V is velocity around central mass		
G=rMV^2/MM				
G=rV^2/M				
r=GM/V^2				
V=(GM/r)^.5				

The following diagram describes expansion of one cell. The orbital kinetic energy (10.15 mev) causes lateral velocity V/C=0.374. Expansion is upward in the diagram below and is caused by time and expansion kinetic energy. Outward inertial force M V^2/r balances the gravitational force F=GMM/r^2 between the two particles of mass 939.56 mev (1.67e-27 kg).

Proton size space

	PE expansion	PE=integral F dR	
	V expansion	Ke=0.5MV^2/2	
		divide by 2 only M has V	



	F		
Ff=E/R/exp(90	2		
Fg=GM*M/R^2	1		
Fi=M*V^2/R	1		

				GRAVITY
				mass only
				proton+elec
Particle Mass (mev)				129.541
M (kg)				2.309E-28
Field Energy (mev)				2.683
Kinetic Energy (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/(2pi)/(E*m/g)^0.5**		**1.0584E-14**

Using inertial force, the gravitational constant G can be calculated at the size of the proton:

Calculation of gravitational constant from Inertial Force				
Radius R (Meters)				1.0584E-14
Mass (kg)	(proton + electron)			1.674E-27
Inertial Force=(m*V^2/R)*1/EXP(90)				1.6309E-36
Gravitational Constant (g=F*R^2/M^2=nt m^2/kg^2)				6.5233E-11
		Proton + elect		6.5233E-11
		End of expansion		6.73E-11
		Published PDG		6.6743E-11

Note the factor exp(90) is explained in reference 1. The gravitational constant G is held constant by the values r and M in the equations above, since V, r and M fix the geodesic.

Making proton size space into universe size space

The universe will be considered as expanding cells surrounding protons. Using WMAP data, reference 1 estimated that there are approximately exp(180) protons (reviewed later). In three dimensions each radius will be multiplied by exp(60) to estimate the full radius. The reason to consider the universe as many expanding cells is that the proton and its associated gravitational orbit (described in reference 1) define space at the proton level. The other reason to do this is that it places protons in the universe in a uniform manner. The universe is known to be very uniform overall but of course the protons can move around in space.

Radius of each cell rcell=r*g^(2/3) +c*g^(5/3)*H*alpha/1.666
Lower case r in the equation above becomes universe size space (R) when rcell is multiplied by exp(60).

How orbital kinetic energy falls as space expands

The following analysis shows what happens to orbital kinetic energy as G=rV^2/M remains constant and r expands to R. Lateral velocity of the orbiting proton V falls to v as r becomes R.

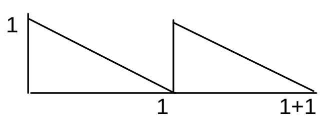
	space		fundamentals				
	RV^2/(M/g)	G=G	rv^2/(M/g0)				
	But the universe expands and r=1e-14 is scaled up by time^(2/3)						
	R space becomes r*time^(2/3)						
	what happens to v^2 so that G=rv^2/M remains constant when r expands?						
RV^2/(M/g)=rv^2/(M/g0)		RV^2/M=rv^2/m	10.15	ke	ke=.5 (m/g)v^2		
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)		

The result is that orbital kinetic energy falls in proportion to expansion. (Origin of the 10.15 mev orbital kinetic energy is described in the section entitled “How nature achieves high potential energy”.)

The geodesic

The geodesic is the space-time curvature partially dependent on gamma (g) that matches the orbit in a way that no forces are experienced by a particle on the geodesic. The equations for the geodesic are from relativity.

V/C=d/(ct)



gamma (g)=t/T=tc/cT

This diagram repeats with time
flow 1,2,3 etc. ⟶
As it repeats, the universe expands

gamma represents a shift in a time ratio (t/T)
V/C represents a shift in the distance ratio
Defined orthagonally:
(V/C)^2+(g)^2=1
(sides make a right triangle)
This leads to the famous Einstein relationship:
g=(1-(v/c)^2)^.5 v/c=(1-(g)^2)^0.5
1=1/g*((1-(v/c)^2)^.5
(1/g)^2(1-(v/c)^2)=1
(1/g)^2-(1/g)^2(v/c)^2=1
(1/g)^2=1+(1/g)^2(v/c)^2
(m/g)^2=(m)^2+(m/g)^2(v/c)^2
(m/g)^2c^4=m^2c^4+(m/g)^2v^2c^2
(mc^2/g)^2=(mc^2)^2+(m/g)^2v^2c^2
With p=momentum, E=m'c^2 and m'c=p below
E^2=(mc^2)^2+p^2c^2

Comparing the proton scale geodesic to gravity

Our understanding of gravity is not complete until we see how the geodesic changes in expanding space. The understanding given by the theory of general relativity was that the orbit is a geodesic (R) when gravitational forces balance inertial forces. However, it is possible that the position and velocity of a particle does not place it on the geodesic.

With M constant, R depends on velocity in the geodesic equation, but gamma (g) is also dependent on V.

Geodesic radius: r=GM/V^2

v/c=(1-(g)^2)^0.5

G=rV^2/M	
G=rC^2(V/C)^2/M	
(V/C)^2+(g)^2=1	
(V/C)^2=1-(g)^2	
G=r/MC^2(1-g^2)	

In the equation above one can see that a very specific relationship between r and gamma must be maintained to be on the geodesic radius. For example, standing here on earth our velocity is too low to be in orbit. The radius that would be determined for a Newtonian orbit does not match the geodesic radius. Our radius is too curved for our velocity (it is determined by the radius of the earth) and we are being accelerated by the equation a=G M earth/R earth^2. If we could gain about 5000 meters/sec (and go above the earth to keep from hitting things) we could attain an orbit that would match the geodesic.

The geodesic in an expanding universe

The following table puts all of the derivations above into action. R universe is estimated to be about 8.8e25 meters at 13 billion years. This is dependent also on the cosmological constant calculation (R3 below). When the slope of the integration ends we would look for H to be the measured value 2.3e-18/sec. It does in the calculation shown.

There are many results in tables below for the start of expansion and the end of expansion. Note primarily that the calculated gravitation constant G is constant throughout expansion. The second table shows that the inertial force and gravitational attraction are balanced with the same radius R. This indicates that the R is the geodesic radius. There are slight differences at the beginning due to effects of g, but forces are balanced throughout the majority of expansion. This shows how G remains substantially constant throughout expansion. I suspect that this might not be true in cosmological calculations that do not use this cellular approach.

Expansion Table (first 3 time steps)

alpha (initial time in sec		0.0011	Start	42.065=LN(0.0011/5.93e-22)		
logarithm used to increase time (LN)				42.06504465	42.33120465	42.59736
time--seconds		EXP(LN)*5.93E-22	time	0.0011	0.001435438	0.001873
		5.93E-22	**5.93E-22**	5.92619E-22	5.92619E-22	5.93E-22
g time ratio	1	time/alpha	1	1	1.304943833	1.702878
Cell radius	**1.02E-14**	**R=R1+R3**	**1.06E-14**	**1.06E-14**	**1.26E-14**	**1.46E-14**
		R1	1.06E-14	1.0563E-14	1.261E-14	1.459E-14
		R3		1.12E-35	1.75E-35	2.73E-35
R universe	8.8E+25	(R1+R3)*exp(60)	1.20635E+12	1.20635E+12	1.44058E+12	1.67E+12
	130.05187	mass mev	130.0518691	130.0518691	130.0518691	130.0519
0.987	0.9276	gamma (g)	0.9276	0.9276	0.9386	0.9471
ke orbit	10.15127	mev	10.15127013	10.15127013	8.50	7.26
V/C orbit	0.3736		0.3736	0.3736	0.3449	0.3209
velocity	3.00E+08	m/sec	1.12E+08	1.12E+08	1.03E+08	9.62E+07
Fgravity (nt)	1.80E-36	F=M V^2/R	1.63E-36	1.63E-36	1.16E-36	8.70E-37
G at end	6.75E-11	G=F/M^2*R^2/exp(9	6.48E-11	6.48E-11	6.60E-11	6.61E-11
G at end	6.76E-11	G=rV^2/M/exp(90)	6.49E-11	6.49E-11	6.60E-11	6.61E-11
G at end	6.73E-11	G=r/M*C^2*(1-g^2)/e	6.4877E-11	6.4877E-11	6.6026E-11	6.6125E-11

Expansion table (last few time steps)

alpha (initial time in sec		0.0011	Start		NOW			
logarithm used to increase time (LN)				89.17536	89.44152465	89.44252	90	
time--seconds		EXP(LN)*5.7E-22	5.93E-22	3.17E+17	4.13749E+17	4.14E+17	7.23E+17	
			5.93E-22	5.93E-22	5.92619E-22	5.93E-22	5.93E-22	
G time ratio	1	time/alpha	1	2.88E+20	3.76135E+20	3.77E+20	6.57E+20	2.301E-18
					Now			
Cell radius	**1.02E-14**	**R=R1+R3**	**1.06E-14**	**6.02E-01**	**7.71E-01**	**7.71E-01**	**1.36E+00**	2.301E-18
		R1	1.06E-14	4.609E-01	5.504E-01	5.508E-01	7.987E-01	1.610E-18
R universe		R3		1.41E-01	2.20E-01	2.21E-01	5.58E-01	
	8.8E+25	(R1+R3)*exp(60)	1.20635E+12	6.88E+25	8.80008E+25	8.81E+25	1.55E+26	2.301E-18
	130.05187	mass mev	130.0518691	130.0519	130.0518691	130.0519	130.0519	
0.987	0.9276	gamma (g)	0.9276	1.0000	1.0000	1.0000	1.0000	
ke orbit	10.15127	mev	10.15127013	1.65E-13	1.29E-13	1.29E-13	7.33E-14	
V/C orbit	0.3736		0.3736					
velocity	3.00E+08	m/sec	1.12E+08	15.14	13.38	13.38	10.08	
Fgravity (nt)	1.80E-36	F=M V^2/R	1.63E-36	5.22E-64	3.19E-64	3.18E-64	1.03E-64	
G at end	6.75E-11	G=F/M^2*R^2/exp(9	6.48E-11	6.75E-11	6.75E-11	6.75E-11	6.75E-11	
G at end	6.76E-11	G=rV^2/M/exp(90)	6.49E-11	6.76E-11	6.76E-11	6.76E-11	6.76E-11	
G at end	6.73E-11	G=r/M*C^2*(1-g^2)/e	6.4877E-11	6.7314E-11	6.7314E-11	6.7314E-11	6.7314E-11	

Note that the initial orbital kinetic energy is reduced to the current value of 1.3e-13 mev. It is important to note the current geodesic radius of each cell (0.77 meters) and the current relativistic time shift (1-gamma). This combination gives the gravitational constant in terms of the geodesic for the mass of one proton. This is the curvature of space-time due to the mass of one proton and it must be known to calculate current geodesics of space-time.

low v equation for G		
ke now (mev)		1.29E-13
V now (m/sec)		13.38
(ke/130)	1-g	9.66278E-16
G=rC^2/(M/g)*(2*(1-g))		6.5185E-11
0.77*C^2/1.67e-27/EXP(90)*9.66e-16*2=6.5e-11		
		6.76E-11

Using the geodesic in universe size space

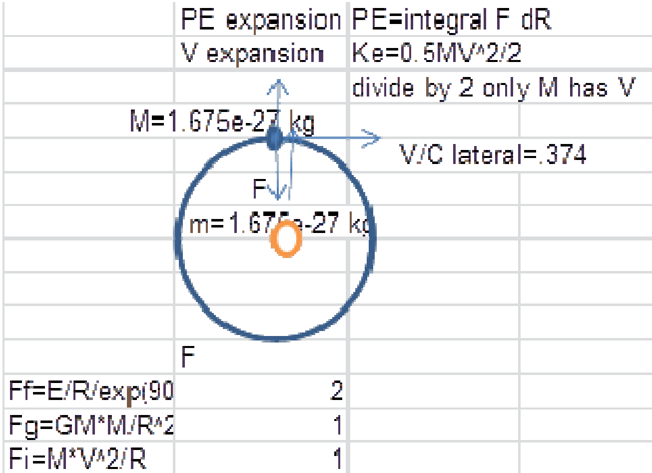
Calculating the geodesic in large space depends on velocity, mass and radius. It has often been stated that mass bends space and bodies follow the curvature. The table above shows equality between the proton size Newtonian radius and the proton size geodesic radius. The work below shows how the geodesic is calculated for universe size space and demonstrates that the calculated geodesic for an earth orbit matches the Newtonian orbital radius. This calculation depends on the values above (r=0.77 m,V=13.5 m/sec and 1.67e-27 kg).

		Mass (earth)	5.98E+24		0.771	This is an intrinsic radius due to expansion		
		earth R (m)	6378100					
	a=gm/r^2	m/sec^2	9.80		1.88E-37	acceleration felt because not on geodesic		
	m	orbit R (m)	6.39E+06					
	a=gm/r^2	m/sec^2	9.75					
		V=(aR/m)^.5	7897.71	meters/sec	13.28	velocity required to achieve geodesic		
						but the particles we experience have lost th		
		Scaling the geodesic to universe sized space				so they give us g		
			space		proton size at current expansion			
R is the universe size R			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 proton size geodesic		
			R'=r*('v/V)^2*(M/m)*1/exp(90)					
					1.00E+00	gamma		
					9.93E-16	1-gamma		
	R earth orbit (meters)		6.39E+06		7.71E-01	r is the cell radius		
	R' geodesic (meters)		6.48E+06		7.706E-01	r' is the proton size geodesic (m)		
	Velocity of orbit (m/sec)		7.90E+03		13.38	meters/sec		
	Earth mass kg		5.98E+24		1.67E-27	kg		
	nt m^2/kg^2		6.76E-11	G=G	6.76E-11	0.904*12.29^2/1.67E-27/EXP(90)		

Note that the proton size calculation for G contains a divisor of 1/exp(90) explained in reference [1][2][6].

Expansion kinetic energy and potential energy

The first line of the derivation (reference 4) for the 8/3 pi G rhoc equation is kinetic energy (ke) = potential energy (pe). (The derivation is repeated later under the heading “Derivation of the critical density equation”). Since expansion is well characterized by WMAP (and agrees with the author’s calculated expansion), one can simply calculate expansion kinetic energy and expansion potential energy as a function of time and determine if initial ke is in fact turned into final pe. A calculation can be carried out for the expansion of each cell containing two particles and the following diagram:



Comparison of calculate kinetic energy of expansion with potential energy using cellular approach:

					v=(keg/c)^.5	Start				Now		Omega
			Time (sec)				0.001100	0.001435	3.2E+17	4.1E+17	4.1E+17	7.2E+17
			Field (mev)		2.683144792	2.683144792	2.683144792	2.683144792	2.683145	2.683144792	2.683145	2.683145
			R			1.056E-14	1.056E-14	1.261E-14	0.602	0.771	0.771	1.357
			Ff=E/R/exp(90)		2	6.6692E-38	6.6692E-38	5.5849E-38	1.1699E-51	9.1425E-52	9.1338E-52	5.1911E-52
			Fg=GMM/R^2/exp(90)		1	1.806E-36	1.675E-36	1.175E-36	5.154E-64	3.148E-64	3.142E-64	1.015E-64
			Fi=MV^2/R/exp(90)		1	1.7569E-36	1.6297E-36	1.1631E-36	5.2233E-64	3.1901E-64	3.1841E-64	1.0285E-64
			V (m/sec)			1.120E+08	1.12E+08	1.03E+08	15.14	13.38	13.38	10.08
							small delta v					
2.31E-37	KE with m (mev)				v	7.185E-12	6.35E-12	6.11E-12	1.69E-18	1.74E-18	1.77E-18	1.90E-18
1.16E-37	ke half	C*m/g*V^2			FINAL PE (MEV)	1.16E-37	2.31E-37	2.12E-37	1.53E-50	1.61E-50	1.67E-50	1.91E-50
1.215	Pef/ke (mev)	Pe=Pe+dPE=Pe+Ff dR		Ff=E/R	1.41E-37	0	0.00E+00	7.81E-40	1.39E-37	1.41E-37	1.41E-37	1.43E-37
0.954	Peg/ke(mev)	Pe=Pe+dPE=Pe+Fg dR		Fg=GmM/R	1.10E-37	0	0.00E+00	1.80E-38	1.10E-37	1.10E-37	1.10E-37	1.10E-37
0.951	Pei/ke (mev)	Pe=Pe+dPE=Pe+Fi dR		Fi=MVo^2/F	1.10E-37	0	0.00E+00	1.76E-38	1.10E-37	1.10E-37	1.10E-37	1.10E-37

The kinetic energy per particle is only 2.31e-37 mev but only half the particles have kinetic energy since half the particles occupy the center of the cell that does not expand. This makes the kinetic energy driving expansion 1.16e-37 mev. The calculations for potential energy compare three alternate forces resisting expansion. The force labeled Ff is the field force where E is 2.68 mev but two particles attract each other and F=2E/R. Fg is the gravitational force GMM/R^2 and Fi is the inertial force Fi=MV^2/R where V is the lateral orbital velocity V/C=0.37 that decreases with increasing R. Based on results in the table above, the closest answer to the question "what resists expansion?" appears to be the gravitational force F=GMM/R^2. For this force, the ratio of initial kinetic energy to final potential energy is 0.954. In other words all of the initial kinetic energy is converted to potential energy at the end of the expansion history shown.

This shows that there is no missing kinetic energy. Recall that the WMAP conclusion was the 0.73 of the total energy was missing and a search for "dark energy" was launched.

Comparison and analysis of the equation H=(8/3 pi G rho)^.5

The values in the boxes labeled v^2 above can be calculated from the accepted expansion curves. The result labeled correct v^2 is simply the velocity of the accepted curve at the end of expansion. This of course is H=3.05e-36/0.767=2.3e-18/sec.

Beginning	Ratio	Now (calc)	
v^2 (m^2/sec^)	calc/correct	v^2 (m^2/sec^)	
		3.032E-36	correct v^2
2.112E-23	0.095	2.895E-37	v^2=(8/3piGrho)*r^2
2.02E-23			correct v^2

The v^2 value from 8/3 pi G rho r^2 is too low by a factor of 0.095 at the end of expansion with rho determined by 1 proton per cell and R equal to 8.8e25 meters. From this comparison, it would be concluded that there is missing mass since rho would have to be 9.5e-27 kg/m^3 to match the correct value v^2= 3.032e-36 (equivalent to H=2.3e-18/sec). But the equation is incorrect.

Why does the conventional equation give incorrect results? The table below shows development of the equation v^2=(8/3 pi G rho)*R^2. The reason to look at v^2 is that it can be directly compared with v^2 from the above tables using the author's cellular expansion velocity v^2. Three columns for calculating potential energy are compared. The first column is the conventional development in which rho is substituted but the column using F=GMM/r^2 is equivalent without the confusing substitutions for rho. The column on the right use F=E/r.

Derivation of critical density equation

	substituting to give rho			using F=gMM/r^2		using F=E/r
ke	pe			correct pe		correct pe
1/2Mv^2	Fr					
1/2Mv^2	GMM/r			GMM/r^2*integral (dr)		F *integral (dr)
ke/M	pe/M			pe/M		pe/M
1/2v^2	GMMr^2/r^3)/m			F/M*integral dr		E/(Mr) *integral dr
	GMr^2/r^3)			GM/r^2*integral (dr)		
	4/3*Gr^2(M/(4/3*pi r^3))					
1/2 v^2	(4/3 pi G rho) r^2					
2 ke/M	2 pe/M			2 pe/M		2 pe/M
v^2	(8/3 pi G rho) r^2			2GM/r^2*integral (dR)		2E/(Mr) *integral (dr)
R=int (vdt)						
R=vt	(this doesn't integrate v as f(dr))					
R=vt=2*(4/3 pi G rho)^.5 R *t						
R	(6 pi G rho R0^3)^.333*t^(2/3)					
R=((8/3G pi rhoc*Rc^3)/R)^.5*t/2						
v/R	2^.5 *(pe)^.5					
H	(8/3 pi G rho)^.5					

The equation V^2=(8/3 pi G rho) r^2 is supposed to represent 2 times the potential energy divided by mass at the end of expansion but in fact it does *not* carry out an integration of the variable forces during expansion. It is normally assumed that rhoc is the final density at R. The value V^2 for the second two columns is simply 2*pe/M and the potential energy integration results are already shown above under the heading “kinetic and potential energy during expansion”. It appears to the author that 8/3 pi G rhoC is a very misused concept since we really want to compare V^2 at the beginning of expansion where kinetic energy (.5MV^2) is the highest (the initial V^2 is 2e-23 m^2/sec^2) with potential energy at the end of expansion (equivalent to 2.07e-23 m^2/sec^2).

How nature achieves high potential energy in an expanded universe

Note that the kinetic energy to expand each cell is on the order of 1.2e-37 mev. Particles that fall into orbits as mass accumulation occurs often have kinetic energy/particle on the order of several mev as shown in the following table for the mass of one proton attracted to a maximum central mass. Particles will fall half way to the center where they establish an orbit with inward and outward forces balanced.

	Central mass--Kg			
	2.47E+51	Filled Surface		de=Fdr
position/R	Radius (meter	Model (nt)		delta pe mev
1.00E+00	5.36E+25	9.535E-38		0.000E+00
9.17E-01	4.91E+25	1.135E-37		2.657E+00
8.33E-01	4.46E+25	1.373E-37		3.162E+00
7.50E-01	4.02E+25	1.695E-37		3.825E+00
6.67E-01	3.57E+25	2.145E-37		4.723E+00
5.83E-01	3.12E+25	2.802E-37		5.977E+00
5.00E-01	2.68E+25	3.814E-37		7.807E+00

Where does the potential energy come from? Note that in the table below, 20.3 mev is set aside for expansion.

Unified.xls cell g191				Mass and Kinetic Energy						Field Energ
mass	Energy-mev	S field	Energy	Mass	Difference KE	strong residual ke	Neutrino	Expansion	Strong field	Gravitation
ke		G field	mev	mev	mev	mev	mev	KE	energy mev	Energy mev
15.432	101.95	17.432	753.29	101.947	641.880				-753.29	
12.432	5.08	10.432	0.69							-0.69
13.432	13.80	15.432	101.95	13.797	78.685				-101.95	
12.432	5.08	10.432	0.69							-0.69
13.432	13.80	15.432	101.95	13.797	78.685				-101.95	
12.432	5.08	10.432	0.69							-0.69
						10.15		20.303		
10.408	0.67	0.075		0.000	0.000					
-10.333										
10.333	0.6224	0	2.02E-05	0.6224	0.000		2.02E-05		-2.02E-05	
0	2.02E-05	10.333	0.6224							-0.6224
				130.163	799.251	**939.5653531**	2.02E-05	20.303	-957.185	-2.683
90.000	sum	90.000				**NEUTRON MASS**		Total m+ke	Total fields	

The model above identifies an orbit that establishes and maintains gravity at G. That orbit is established when 20.3 mev protons fall into an orbit with 10.15 mev of kinetic energy and 10.15 mev of potential energy. That orbit has a high velocity (0.37C) that gives an outward centrifugal force that balances the crushing F=GMM/R^2 at small r. As the smaller kinetic energy of expansion and time drive expansion, r becomes larger but the kinetic energy of 10.15mev quickly falls. From conservation of energy, the potential energy of particles achieves the value 20.3 mev. It is this energy that we see when orbits are established around galaxies and planetary systems. It is also this energy that provides pressures and temperatures high enough to initiate fusion.

Dark Matter

There is a way to determine whether dark matter exists. WMAP used the difference in time between two important transitions to determine the size of the acoustic spots detected by radiometers. Those two transitions were 1) equality of energy and mass when acoustical waves develop and 2) decoupling where the universe becomes transparent as the plasma clears. The following table is from Reference 2.

	Equality=1, Decoupling=.5 and h=2.302e-18 are the matches required.											
					129.541		t=alpha*G			"Universe"		1.675E-27
					Expanded	R1		1.06E-21	R3	R1+R3	Temperatu	Mass
			G	G^(2/3)	radius per	Time^2/3	Time (sec)	Time (years	G^(5/3)			density
					particle (m)	meters			meters	meters	T=Rnow/R*2.725	
End of inflation		1	1	1	**1.0584E-14**	1.2087E+12	1.100E-03	3.488E-11	1.28E-09	1.2087E+12		3.372E+14
		28	1.44626E+12	127888157	**1.3536E-06**	1.5458E+20	1.591E+09	5.045E+01	2.38E+11	1.5458E+20	1.554E+06	1.6123E-10
Equality	9.493E-01	35.776	3.44603E+15	2.281E+10	**2.4148E-04**	2.7577E+22	3.791E+12	1.202E+05	1.01E+17	2.7577E+22	8712.3	2.8398E-17
Decoupling	8.1362E-01	37.4	1.74829E+16	6.736E+10	**7.1297E-04**	8.1421E+22	1.923E+13	6.098E+05	1.51E+18	8.1423E+22	2950.7	1.1032E-18
Now	2.3009E-18	h	3.761E+20	5.211E+13	**5.5152E-01**	6.2984E+25	4.13752E+17	1.312E+10	2.52E+25	8.8167E+25	2.725	8.6894E-28

"Universe"		1.675E-27			
R1+R3	Temperatu	Mass	Radiation	Saha	
		density	density		
meters	T=Rnow/R*2.725				Z
1.2087E+12		3.372E+14			
1.5458E+20	1.554E+06	1.6123E-10	2.73E-08		
2.7577E+22	8712.3	2.8398E-17	2.70E-17	1.8124E-15	3197.1561
8.1423E+22	2950.7	1.1032E-18	3.55E-19	8.1362E-01	1082.8323
8.8167E+25	2.725	8.6894E-28	2.58E-31		0

Mass density is compared with radiation density and when the ratio is close to 1 equality has occurred. The mass density in the above calculation is based on Mu/volume (kg/m^3)=exp(180)*1.67e-27/(4/3*pi()*8.75e25^3). The author used exp(180) cells to determine R but expansion kinetic energy and potential energy only match if there are 2 protons per cell. At the match there is enough initial kinetic energy in one proton to impart an equivalent amount of final potential energy against the resisting gravitational force between 2 protons. That leaves the central "proton" per cell as an unknown. Perhaps it doesn't appear in the equality calculation because it is transparent to the balancing radiation energy and is neutral. This is the current working assumption for dark matter.

Conclusion

Using a cellular approach to estimate the size of the universe allows one to understand expansion. Equations were developed based on space expanding as time to the (2/3) power and a cosmological constant integration yielding a second expansion term proportional to time to the (5/3) power. The results agree with the WMAP expansion curve.

Constants for the above equations help us understand what space is and how protons are placed within space. Space is created at the proton size and expands to universe size space.

An approach to calculating the geodesic radius was presented for both proton size space and universe size space which shows that the geodesic changes appropriately during expansion to keep the gravitational constant G constant. The geodesic radius matches the gravitational orbital radius as space expands.

The kinetic energy of expansion and the conversion to potential energy was examined with the cellular approach. It was shown that they match closely when the cellular model contains one proton in the center of a cell and one orbiting proton that expands away from the central proton. The demonstrated match of kinetic energy and potential energy indicates that there is no dark energy.

Is there dark matter? The author believes that dark matter estimates from the equation containing 8/3 pi G rho cannot be relied upon. From the author's analysis, there is enough kinetic energy to "lift" 1 proton to the final cell radius 0.77 meters against a resisting force that stretches gravitational field energy between two proton masses/cell. Based on WMAP reanalysis, equality (of matter and energy at z=1080) was achieved with exp(180) normal protons of mass 1.67e-27 and the volume calculations from the expanded radius. There appears to be one "mysterious proton like mass" per cell that could be dark matter.

References

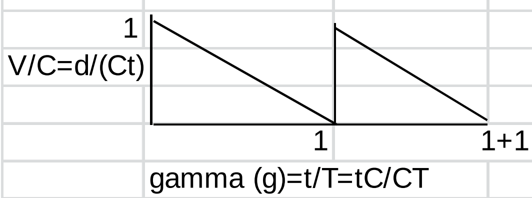
1. Barbee, E. H., Microsoft Word Document, A top down approach to fundamental interactions, fqxi essay June 2012, revised July 2013, viXra:1307.0082. Reference Microsoft ® spreadsheet entitled Unifying concepts.xls, Barbee.
2. Barbee, E. H., Microsoft Word Document, Application of information in the proton mass model to cosmology, viXra: . Reference Microsoft ® spreadsheet entitled simple1c.xls, Barbee.
3. Bennett, C.L. et al. First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Data, Astrophysical Journal, 2001
4. Peebles, P.J.E., Principles of Physical Cosmology, Princeton University Press, 1993.

5. A. Conley, et al, (THE SUPERNOVA COSMOLOGY PROJECT), Measurement of Omega mass and Omega lambda from a blind analysis of Type1a supernovae with CMAGIC.
6. Barbee, E.H., Microsoft Word Document, The case for a low gravitational scale, July 2013.

.

Appendix 1 In a relativistic universe is anything constant?

Why is the speed of light a constant?



d in the diagram above is distance
Light is shifted totally into the vertical axis at C/C.
Light energy is not lost as time ticks to 1, 1+1, etc.
In a moving time frame it travels to the next 1
on the horizontal axis.
The vertical axis can also be written V=dC/(Ct)
At the next 1 light travelled dC*t/(Ct)*t=Ct=d
So in time t light travelled d and d/t=C
The vertical axis is d
The horizontal axis is t
Light speed is just the ratio between dimensions that
are equal and orthogonal.

Finally, 4 dimensional space is described by Minkowki. Minkowski space would be slightly changed by the general theory of relativity since curvature is not part of the Minkowski analysis. However, this analysis shows that space is so slightly curved at a velocity of 13 meters/sec that the curvature can be ignored.

The author notes, but has not fully explored that fact that R=Constant/(2.68*939.56/g)^.5 should contain a g value but in fact everything works out better if g=1 rather than 0.927. Some physicists believe that at the fundamental level there must be an absolute velocity to prevent everything from being self-referencing.