Gene H Barbee

December 21, 2015 revised January, 2017

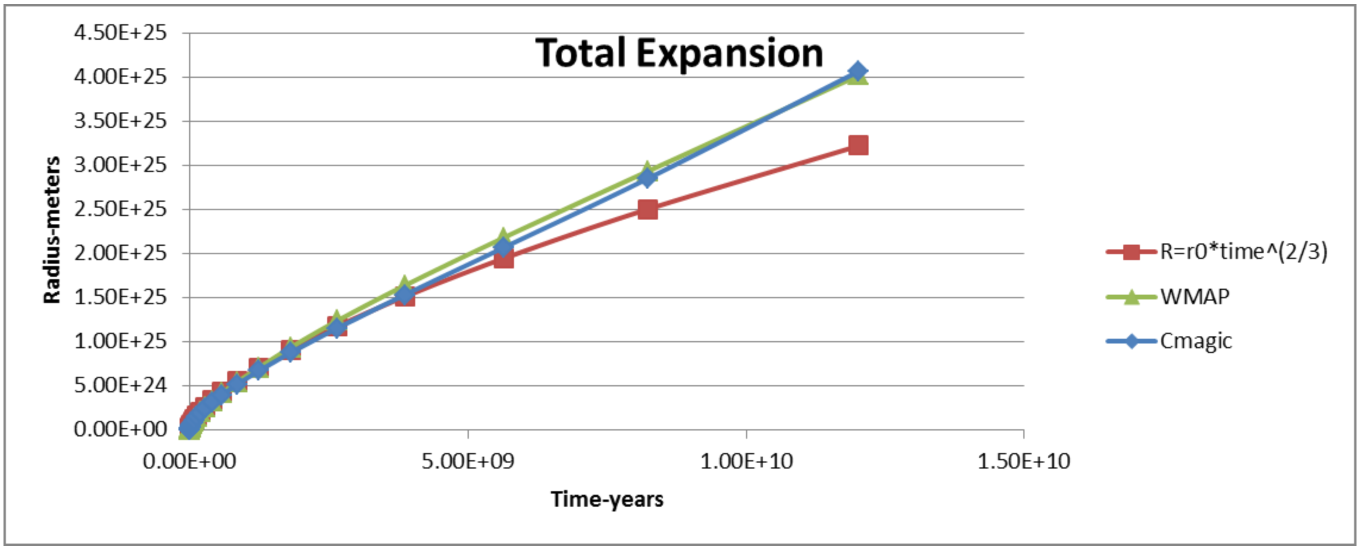
Original version viXra:1511.0185v1

Dark Energy

Abstract
Observations of the universe's expansion created discussion regarding dark energy. There is consensus that late stage expansion currently is more linear than the equation R=r0*(t/t0)^(2/3). Since this equation represents conversion of kinetic energy to potential energy and is a curve, Hubble data showing that late stage expansion is almost linear appears to violate energy conservation and require a dark (unknown) energy source. Two literature proposals (cosmological constant and quintessence) attempt to account for this unknown energy source.

This paper presents calculations indicating that energy produced by stars causes the linear expansion curve. The analysis draws on data regarding the relative abundance of elements to determine the number of stars and their energy output. A calculation procedure for expansion was developed that allows one to add energy and predict its effect on late stage expansion. It was surprising that a small amount of energy has a large effect on expansion. At the same time, the required energy addition has only a small effect on current temperature (2.73K). Energy produced by stars is fusion energy and provides a physical alternative to dark energy. Current cosmology is based on mass with kinetic energy but includes a large fraction (0.719) of dark energy. The expansion curve, energy release points and associated temperature curve is presented. Analysis shows that although the density is 9.14e-27 kg/m^3, the mass fractions should be 0.5 normal and 0.5 dark.

Background
Expansion and cosmology parameters are currently based on differential radiometer projects known as COBE, WMAP [3][7][5], and Planck. They are compared to supernova data from Cmagic [5] that suggest an accelerating universe. After He4 fusion expansion is radiation driven R=r*t^0.5 but after decoupling the plasma clears and expansion follows R=r*t^(2/3). But R=r*t^(2/3) gives the wrong Hubble constant (slope of the expansion curve/divided by the radius at the present time equal to 2.26e-18/sec [7]). This means a second expansion component must be added, but what causes it? The graph below shows the problem. Data suggests the upper curve but this requires an unknown energy source. The concept "dark energy" is a placeholder and the author explored the possibility that energy produced by stars is the unknown energy source.



Exploration

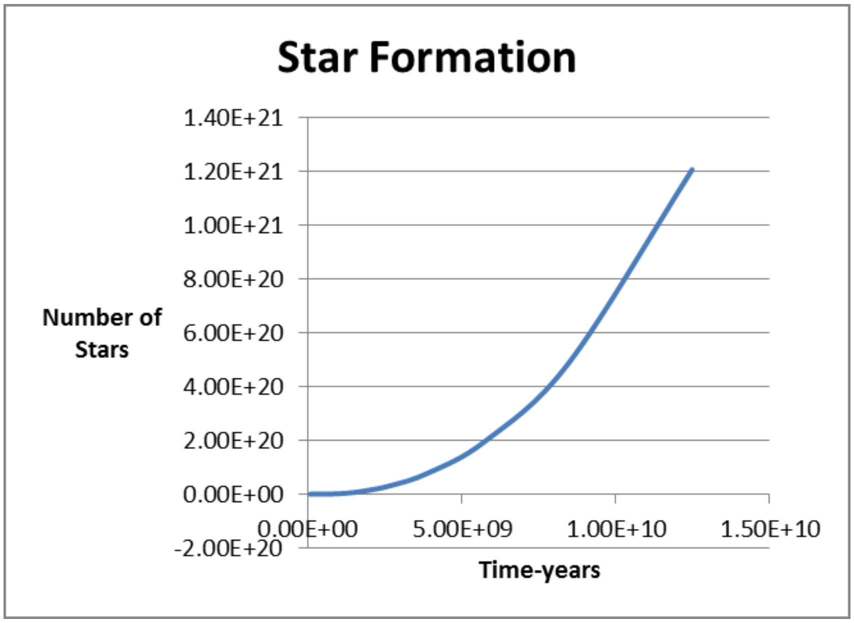
The dark sky temperature is 2.725K. However, recall that the WMAP and other radiometer projects blocked out light from stars since these photons originate from surfaces that are about 5780 K. Star formation starts at about z=16 (Rf/R-1) after the beginning. The average star is about 5e29 Kg [4] but there are potentially over 6e20 stars if their mass is 2e30 kg similar to our sun. The sun emits 2.37e39 MeV/second and will burn for 7-8 billion years. Since early star formation a lot of atoms have moved through a well-documented solar burning cycle. Our sun is mainly hydrogen but a supernova in our vicinity produced the heavier elements that make up the earth and other planets. Heavier elements are measured throughout the universe and NIST publishes data regarding elemental abundance. The universe is also mainly hydrogen but the abundance of Helium4 is uniformly 23-25%. It is widely accepted to be a result of primordial nucleosynthesis that occurred (in my analysis) at 549 seconds after the beginning. Deuterium, He3 and Li7 were also produced by primordial nucleosynthesis and their abundance provides a marker for our understanding of this period [12][18]. Fusion energy was produced by each element involved in star evolution and their measured abundance multiplied by their binding energy give us the total energy produced by stars. The table below shows the energy released by a few elements involved in star evolution [17].

		0.487	MeV stars
fractional	Binding		
abundanc	Energy	9.29E-01	Mev total
5.00E-07	2.490	4.15E-07	He3
2.50E-01	7.075	4.42E-01	He4 prim
	7.075	4.37E-01	He4 star
6.00E-09	5.644	4.84E-09	Li7
2.00E-09	6.492	1.44E-09	Be
2.00E-09	6.952	1.26E-09	B11
5.00E-03	7.681	3.20E-03	C12
1.00E-03	7.477	5.34E-04	N14
1.00E-02	7.977	4.99E-03	O16

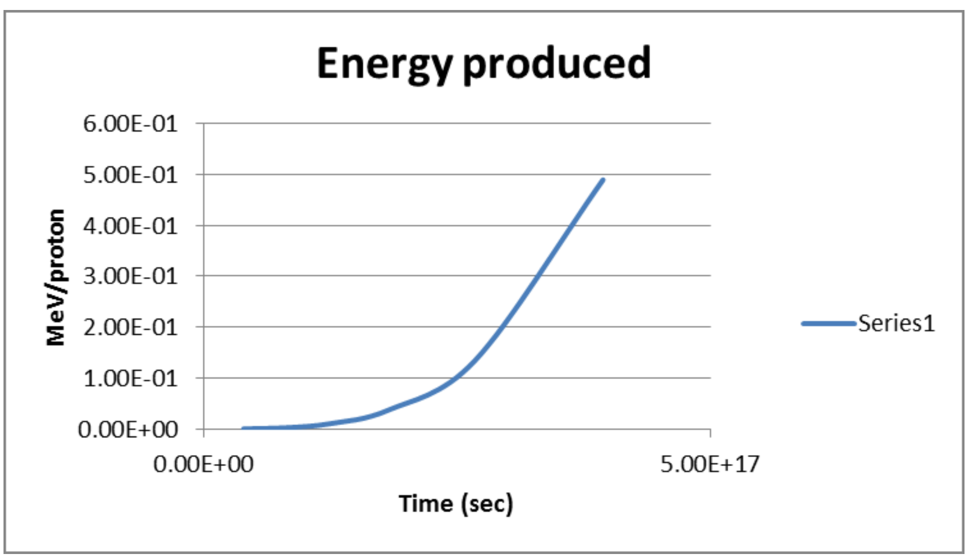
Primordial Helium4 fusion released 0.442 MeV/proton but much later the stars produced an additional 0.49 MeV/proton. Primordial fusion makes up most of the CBR but has been reduced to about 3e-10 MeV/proton by expansion (energy later=energy release/expansion ratio. Another 0.49 MeV/proton was released after stars formed and is less reduced because the expansion ratio was only 15 for the earliest stars. About 0.44 of the 0.49 total is first stage H2→He4 solar fusion as shown in the following calculation. The calculation is based on Wiki data solar output (2.37e39 MeV/sec) and 7e9 years of solar burn time. The other "burns" during the life cycle of stars (He→C→O→Fe) [Wiki][11] are short lived and contribute the remaining 0.03 MeV of the energy produced by stars.

Our goal is to determine the expansion energy available after stars form. We will base our estimate on stars that are similar to our sun. The first step is to determine the number of stars that have contributed to the 0.49 MeV/proton total as a function of time. There are 0.5*exp(180) protons (see section entitled "Recalculating parameters with a new critical density" below) each releasing 0.49 MeV. This large amount of energy is more than the total energy of the dark sky at 2.73K and cannot be ignored.

Since star formation rate increased resulted with time from z=16 and integration of the number of stars is shown below. Sensitivity to other formation rates was examined but results indicated the exact curve was not important to the final result.



Stars that form early have been burning a long time but there are not as many of these. Stars that form later haven't burned as long but the total energy for all the stars can be calculated. Energy accumulates over time because there is no place for it to go. An incremental calculation was used with energy from the previous step reduced by the expansion ratio. The values are plotted below. The final step represents 0.49 MeV/proton. Most of this energy is used to raise the internal energy of stars.



To understand how energy drives expansion, one must know the forces involved. We will use an approach that gives the force on each free proton. The energy will be an overall value reduced to a small representative value for each proton. I used this approach successfully to understand gravity [6][13] and call it cellular cosmology (Appendix 1). In cellular cosmology we deal with one proton circling another proton bound by gravity. The outer proton has kinetic energy associated with V below, but the forces have been scaled down by exp(90) between protons. We use exp(180) protons. In thee dimensions, the scale is now R/exp(60). The advantage is that we know some of the values. They are found in the proton mass model (see Appendix topic "Proton mass model"). One important value is the initial expansion kinetic energy, 10.15 MeV.

Constructing the complete expansion curve

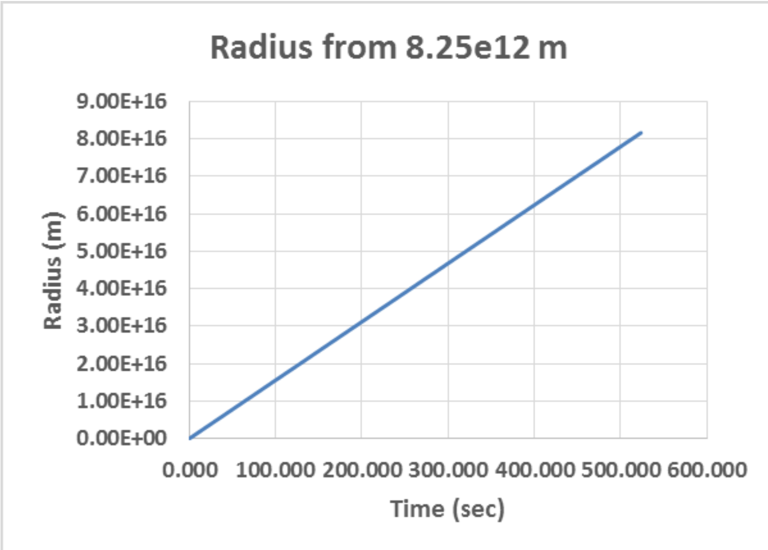
We will start from the beginning and calculate the radius increase from R0 to Rh where He4 forms. We find values in the proton mass model that give the starting radius. It is related to values from the proton mass model, specifically E=2.732 MeV in the equations below.

Identify the radius and time for the gravitational orbit described above		
Fundamental radius=1.93e-13/(2.732*2.732)^.5=7.224e-14 meters		
Fundamental time=7.224e-14*2*PI()/(3e8)=h/E=4.13e-21/2.732		
Fundamental time	1.514E-21	seconds

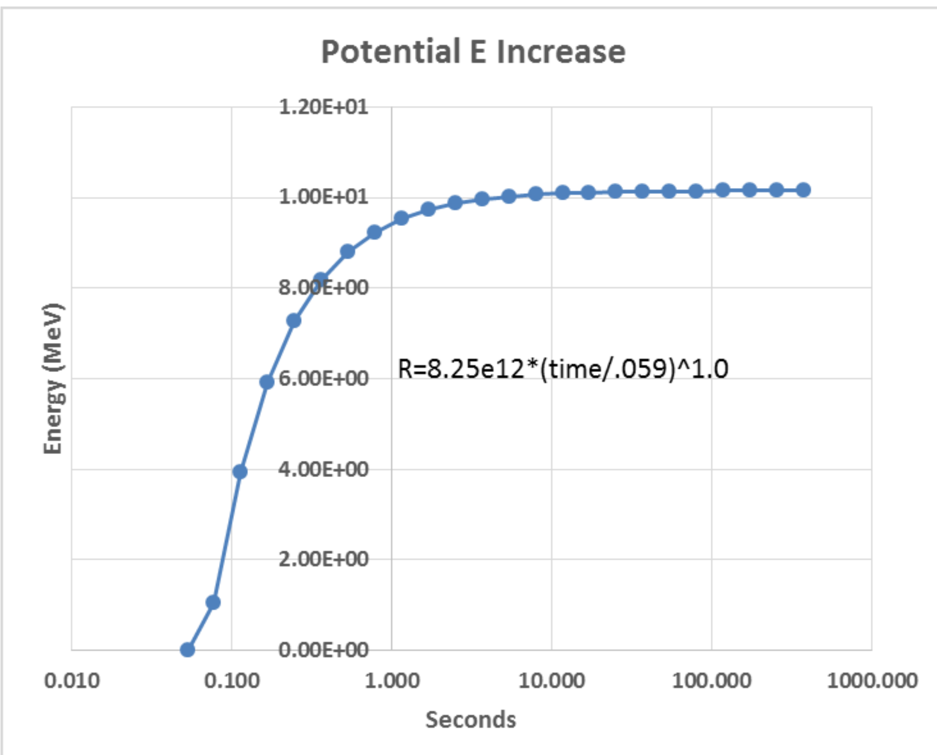
In a three dimensional universe exp(180/3) is the radius multiplier. The radius at the end of the duplication process is 7.22e-14 *exp(60)=8.24e12 meters [10].

Stage 1: Rapid Expansion increases the radius from 8.24e12 to 7e16 meters

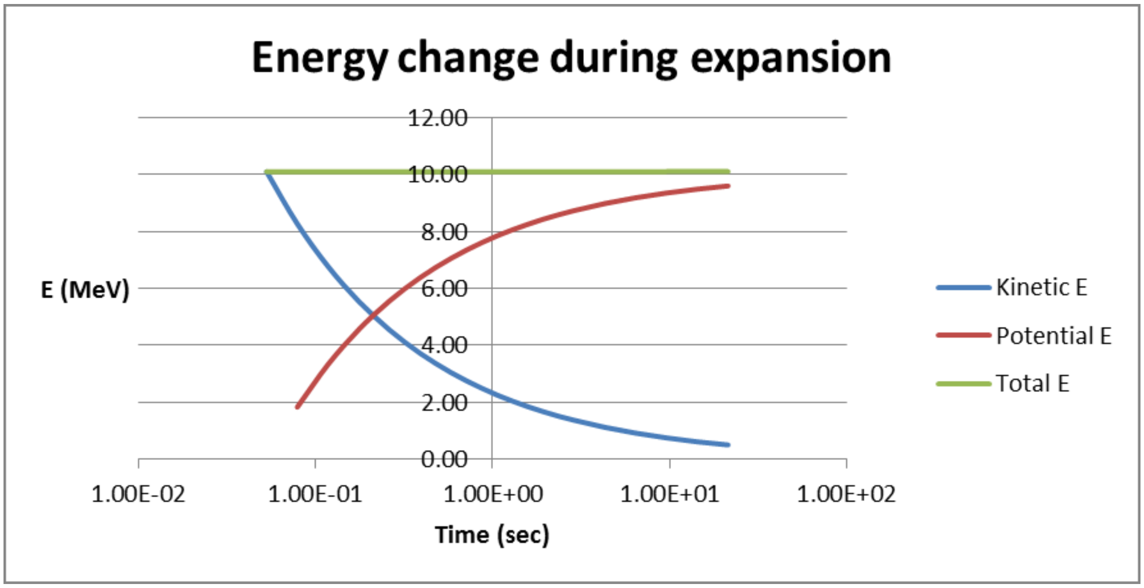
The proton model above has been described many times [14]. We don't know the relationship between time and radius. However direct expansion with time; i.e. R=R0*(time/time0)^1 works perfectly for this stage. I use a time scale that starts at the natural log value 45. But we must also know the units. The time I call cosmological time is one time around the circle 7.22e-14 meters at velocity C. Cosmological time equals 2*pi*7.22e-14/3e8=1.51e-21 seconds. Time0=exp(45)*1.51e-21=0.059 seconds. The time scale is constructed by adding small constant increments to 45. This defines the expansion curve from the beginning R0=8.25e12 to Rh=2e17 meters. Here is the relationship between radius and time:



The following chart shows the kinetic energy 10.15 MeV being converted to potential energy as a function of time.



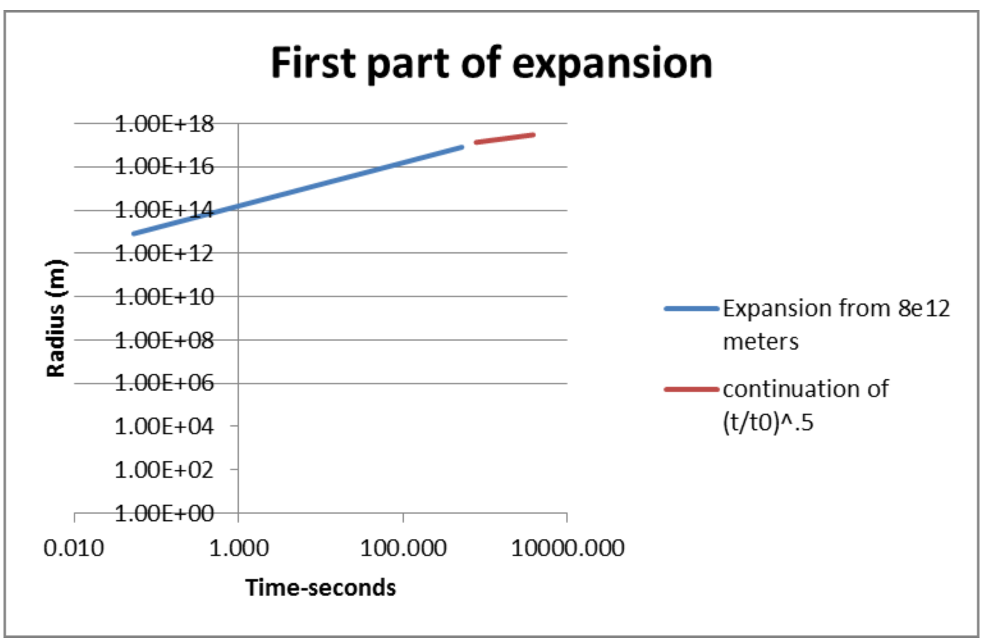
This increase in potential energy means that kinetic energy is reduced and is the low value 0.11 MeV at 1e17 meters expansion. This calculation is made possible by the use of the equations $F=mV^2/R/\exp(90)$ and Potential energy = integral $F*dR$.



He4 forms right after the temperature falls to 8e8 K and the energy released increases the temperature to 1e9 K [Appendix topic "Details of primordial nucleosynthesis"].

Stage 2: Radiation driven expansion occurs from 2.07e17 meters to 3.06e21 meters where the plasma clears.

The next part of the curve must match the curve at Rh (helium production).



We construct the next part of the curve from Rh, the point where primordial He formed. This is predicted by the SAHA value 1 for deuterium which occurs at 8e8 K. There is agreement plasma exists and expansion is radiation dominated [19]. The physics of radiation driven expansion is a function of time to the 0.5 power [10]. That is, Rd=2.07e17/(3.19e13/549)^0.5=3.06e22 meters.

Stage 3: Expansion increases the radius from 3.02e22 meters to 1.24e24 meters where star energy becomes important. R1=r0*t^(2/3) is the Friedmann [4] equation and can be derived from H^2=H0^2(fraction*(1-z)^3). R1 continues to the present time with R1=constant*time^(2/3).

Stage 4: Energy from stars increases the radius beginning at 1.24e24 meters and continuing to the current radius at 4.02e25 meters.

WMAP year 9 gives a Hubble constant of 2.6e-18/sec. The integration to 4.02e25 meters stops at this point because it yields the measured value. The universe would expand only to 3.14e25 meters without radiation from the stars. Details are under the heading "The effect of star energy on expansion".

Energy history summary

Energy is available at the beginning and added in two additional places in the expansion curve. An initial kinetic energy of 10.15 MeV/proton comes from the proton mass model [1] [10](Appendix 1). The current energy can be calculated from the Boltzmann relationship; E=1.5*B*T, where B is 8.62e-11 MeV/K.

Secondly He4 fusion releases 1.6 MeV/proton when He4 forms (called primordial nucleosynthesis in the literature). The temperature decreases to near it present value. Lastly, energy is added by star formation after radius 2e24 meters (z=15). This brings the temperature to the measured value 2.73 K.

The arrows labelled reduced show the change in the energy value/proton due to expansion.

	Summary of energy releases during expansion					
	Stage 1 start	Stage 2 start	Stage 3 start	Stage 4 start	Expanded Energy	
	Initial Energy	He4 fusion	r=r*t^(2/3)	Star energy	now	
					(MeV/proton)	
R meters	8.25E+12	2.00E+17	2.03E+21	6.70E+24	3.12E+25	no stars
		reduced				
MeV/proton	10.15	→ 0.11				
MeV/proton		0.555	reduced	→	1.82E-10	
MeV/proton				e addition →	1.71E-10	
R delta (meters)					8.70E+24	
					4.02E+25	stars

The original 10.15 MeV/proton has been reduced by expansion (kinetic energy being converted to potential energy) to 0.11 MeV/proton at 5.82e16 meters. The SAHA equation for deuterium predicts equilibrium at 8e8 K [8] and 2.07e17 meters. At this point deuterium combines into He4. The energy released is 0.25*7.07/4=0.44 MeV, where 7.07 is the binding energy for He4 (the divisor 4 is the number of nucleons in He4 and the total is 0.44 +.11=.55 MeV.

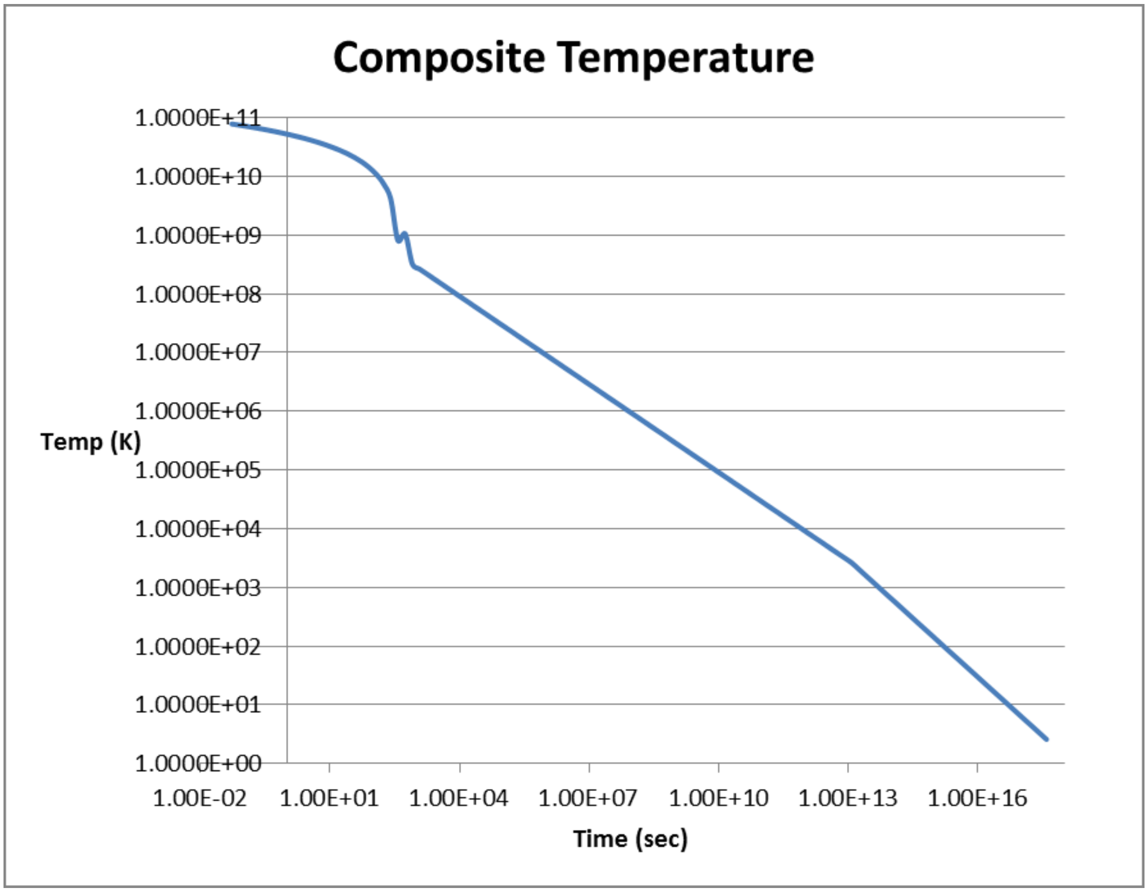
Binding Energy			
MeV	Number	dq MeV	
7.07	4.65E+76	3.29E+77	He4 binding energy*0.5*exp(180)*.25/4
0.11	7.45E+77	8.19E+76	Energy remaining from 10.15 MeV initial energy
		4.11E+77	sum dq MeV
		0.552	MeV/proton

We see some of this energy in the current CBR. There are four components to the plasma; protons, dark matter, photons and free electrons (and massless neutrinos). An equation is found in the above reference for the energy of three components. The table below is for 1.06e9 K:

8.47E+15	1.25E+16	1.83E+16	2.69E+16	3.96E+16	5.82E+16	2.07E+17	2.51E+17	3.05E+17	3.70E+17
1.7703E+10	1.4326E+10	1.0948E+10	7.5707E+09	4.1932E+09	8.1559E+08	1.0599E+09	3.2159E+08	2.6524E+08	2.1876E+08
T (K)	1.06E+09	938.27	1.67012E-27	v=(8kT/mpi)^.5	Protons	1.16E-01	9.59E-02	7.91E-02	6.52E-02
		938.27	1.67012E-27		Dark matter		9.59E-02	7.91E-02	6.52E-02
T (K)	1.06E+09	938.27	1.67012E-27	KE=T*1.5 B	Photons	1.37E-01	4.16E-02	3.43E-02	2.83E-02
T (K)	1.06E+09	0.511	9.0958E-31	v=(8kT/mpi)^.5	Electrons	1.16E-01	9.59E-02	7.91E-02	6.52E-02
				1	0.399	0.399	Tphotons at present (K) →		2.57

The total energy for the plasma components compares with the He4 energy release above (0.551 MeV/proton). Expansion reduces the photon value to 1.82e-10 MEV (1.4 K). Stars produce 0.49 MeV/proton late in expansion but most of this energy is stored in the star's temperature. The energy released and a source for expansion is calculated by using the Stephan Boltzmann equation and a surface temperature of 5780K. Stars add 1.71e-10 MeV/proton, increasing the temperature to the measured value 2.73 K (much more on this in the section entitled "Fraction of star energy available for expansion".

The energy history can be converted to a temperature history though the Boltzmann constant. It is shown below and clearly the energy remaining is the CBR.



The beginning temperature (3.92e10 K at 10.15 MeV) starts to fall and dives when the kinetic energy is nearly depleted. When the temperature hits 8e8 K the SAHA equation for deuterium initiates He4 fusion. This causes a spike in temperature to 1.06e9 K but then continues to fall according to Rh/R. The break in the curve at 3e13 seconds is decoupling where expansion follows a 2/3 power rather than the earlier ½ power.

Forces that determine expansion

We all use time ratios for expansion but what are the actual forces that cause particles to expand away from each other? I used cellular cosmology to calculate forces. The derivation below shows a different way to write equations that obey Newtonian gravity. The coupling constant for gravity is a published value 1.16e-51 Mev M (Wiki). The equation G=F r^/M^2 can also be written in terms of kinetic energy. That equation would be:

derive coupling constant c^2		
G/1.603e-13=2 ke R/Mm		
G*1.67e-27^2/1.603e-13=2 ke R/Nn		
Nn=1 for coupling constant		
1.16045E-51	mev m	
1.16716E-51	Mev m	Published
nt m^2/kg^2*kg^2 mev/(nt m)		
Mev m		
1.16e-51*exp(90)/2		
7.08107E-13	Ke r	(MeV m)

The coupling constant is scaled down to one proton orbiting a central mass of one proton at KE by applying exp(90)/2. The 2 makes it kinetic energy and exp(90) scales the calculation to one proton orbiting another proton. Kinetic energy (MeV) for a known radius r is 7.08e-13/r with r in meters.

R (meters)	5.43E+17	6.59E+17	7.99E+17	9.68E+17	1.17E+18
Temp (K)	8.12E+07	6.70E+07	5.52E+07	4.55E+07	3.76E+07
r=R/exp(60) m	4.76E-09	5.77E-09	6.99E-09	8.48E-09	1.03E-08
coup*ph/pr	7.09E-13	7.09E-13	7.09E-13	7.09E-13	7.09E-13
ke=coup/r	1.06E-02	8.78E-03	7.24E-03	5.97E-03	4.93E-03
g=(939/(939+ke))	**9.9999E-01**	**9.9999E-01**	**9.9999E-01**	**9.9999E-01**	**9.9999E-01**
V=(1-(g)^2)^0.5*C (n	**1.4282E+06**	**1.2971E+06**	**1.1780E+06**	**1.0698E+06**	**9.7154E+05**
F=mV^2/r (Nt)	5.8671E-46	3.9911E-46	2.7149E-46	1.8468E-46	1.2563E-46
E=Fdr (MeV)	0.03	4.52E-03	3.73E-03	3.08E-03	2.54E-03
de from Rh	0.04	7.77E-03	6.41E-03	5.29E-03	4.36E-03

Each column of calculations is a radius increment. R is the expansion curve and T is the temperature curve reported in the section above entitled “Constructing the expansion radius”. The radius r is R/exp(60), again to scale the calculation down to the proton-proton level. Next we determine the orbital ke related to gravity (keg) by the definition of coupling constant above, i.e. Coup=keg*r. We know r and can determine keg. But we know that ke cannot fall below the energy contributed by photons because inertial forces *and* impact by photons drive expansion. The photon energy is kep=T*1.5*B where Boltzmann’s constant B=8.6e-11 MeV/K. With this we put (keg+kep) in the equation for gamma and then determine orbital velocity. From here we can calculate the force F=mV^2/r. Above it is 5.86e-46 Nt for the first increment. Before we leave this table there is a check on the E calculation. Sum across to end E=F dr is equal to the sum of energy across the calculations above in the section entitled “Constructing the temperature history” (0.04&0.03 MeV). We can now actually calculate the next radius in incremental calculations from fundamental forces and do not have to rely on the equation r=r0*(time/time0)^.5. The equation is r=rprior+E/F*1.6e-13/exp(90). From here we can take the scaling out and calculate R=r*exp(60).

We can carry the above incremental calculations to the present time.

	8.70E+24	1.13E+25	1.46E+25	1.88E+25	2.43E+25	3.14E+25	R (meters)
	7.62E-02	9.85E-02	1.27E-01	1.65E-01	2.13E-01	2.75E-01	r=R/exp(60) m
	7.09E-13	7.09E-13	7.09E-13	7.09E-13	7.09E-13	7.09E-13	coup*ph/pr
	1.28E-09	9.91E-10	7.65E-10	5.87E-10	4.37E-10	2.79E-10	ke=coup/r
	2.7321E-12	**2.1124E-12**	**1.6313E-12**	**1.2520E-12**	**9.3263E-13**	**5.9389E-13**	**g=(939/(939+ke))**
	4.9553E+02	**4.3572E+02**	**3.8290E+02**	**3.3544E+02**	**2.8952E+02**	**2.3103E+02**	**V=(1-(g)^2)^0.5*C (m/sec)**
	4.4082E-60	2.6362E-60	1.5746E-60	9.3473E-61	5.3857E-61	2.6527E-61	F=mV^2/r (Nt)
	5.81E-10	4.49E-10	3.47E-10	2.66E-10	1.98E-10	1.26E-10	E=fdr (MeV)
	7.61E-02	9.83E-02	1.27E-01	1.64E-01	2.12E-01	2.75E-01	predicted r (m)

The predicted cell radius r=0.275*exp(60) to match the full radius 3.14e25 meters. The kinetic energy line (yellow) is gravitational kinetic energy plus the photon kinetic energy. To be a true prediction it must depend on values from the prior cell (E=1.98e-10 MeV and F=5.38e-61 Nt). Here is the equation that predicts radius. The factor 0.86 allows the prediction to be accurate over the entire range.

r=rp+E/F*1.6e-13/EXP(90)			
0.275=0.86*(0.213+1.98e-10/5.386e-61*1.6e-13/exp(90))			
0.275			

Energy added by stellar photons

Each star on average contributes 2.37e39 MeV/sec and there are an increasing number of stars after z=15. This method uses the Stephan Boltzmann number (S=3.54e5 MeV/m^2/K^4) and associated equation MeV/sec=S*area*T^4 to calculate the energy from stars.

First check that the star temperature 5778K (Wiki) produces the correct energy. The calculation below where MeV/sec=3.54e5 MeV/m^2/K^4 verifies the output of the sun (Wiki).

5778	Temp surface K
3.54E+05	mev/m^2/K^4
6.96E+08	radius of sun (meters)
6.08E+18	Surface area of sun
2.40E+39	mev/sec/star

Over time there are an increasing number of stars similar to our sun each with a surface temperature of 5778 K. The number of stars and their surface area give us the energy/sec coming from this source. The sky also radiates energy. Its temperature is only 2.73 K but its area is the area associated with the radius of the universe. These two sources can be added together (MeV/sec total=MeV/sec stars+MeV/sec sky) and the increased sky temperature can be calculated by solving the Stephan Boltzmann equation for T. T=((MeV/sec total)/3.54e5/skyarea))^.25. Each temperature is associated with energy and the difference is the kinetic and potential energy change between the original sky temperature and the star augmented sky temperature.

Fraction of star energy delivered

We calculated that there would be about 0.6 MeV/proton considering the fusion energy of all the stars. We now show the fraction of that energy actually available to expand free protons. At this point most matter is in galaxies, etc. that are in orbit. Classically, it is not available to expand any longer because it is gravitationally bound. I assumed that free protons make up about 10% of all matter at the present time but this can be refined. The model for the following calculation is a target proton that expands when it is impacted by photon energy. The entire sky is the source of the photon energy and it contains 6e20 stars each with an area (1.52e18 m^2). The number of photons in the source area equal protons divided by the baryon/photon ratio. There are 1.47e77 target protons (10% of all matter) each with a cross-section to photons of 2e-31 meters^2 (PDG). When all of this estimated, the fraction of the star energy that is actually delivered to their targets is on the order of 1e-10.

1.48E+21	nstars=number of stars/sky area
1.52E+18	source area/star (pi^r^2, where r is star radius) meters^2
4.13E+51	sky area= surface area of the universe modelled as sphere (4pi^Runiverse^2) (meters)^2
9.32E+90	source of photons=nstars/sky area*star area*sky area
2.72E+98	number of photons in source area=source of photons/(nprotons/nphotons) (np/nb=3.4e-8)
1.49E+77	target =number of free protons (about 0.1 of all protons)
2.00E-31	cs=cross section of target proton=2e-31 m^2
3.65E-10	fraction delived to expanding protons (numb photons/target*cs)

Late stage expansion

We are in a position to predict late stage expansion with the energy addition (e). We are interested in its effect on radius and temperature. For example we want to answer the question "how large does e have to be to explain the second component of expansion?" We will focus on the column on the right (the present time).

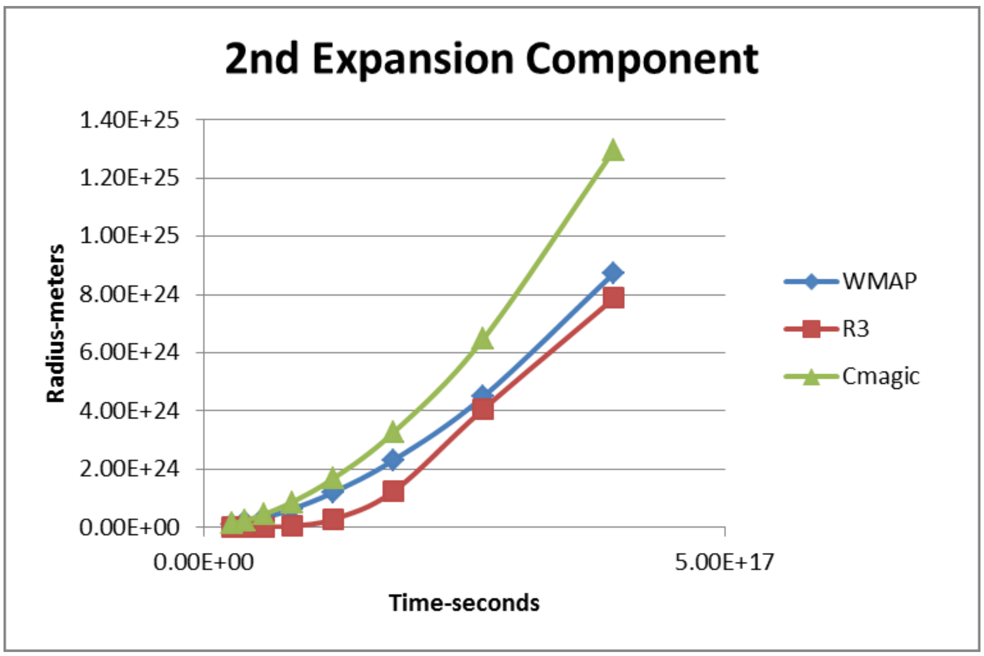
8.70E+24	1.13E+25	1.46E+25	1.88E+25	2.43E+25	3.14E+25	R (meters)		2
7.62E-02	9.85E-02	1.27E-01	1.65E-01	2.13E-01	2.75E-01	r=R/exp(60) m		(
7.09E-13	7.09E-13	7.09E-13	7.09E-13	7.09E-13	7.09E-13	coup*ph/pr		
1.28E-09	9.91E-10	7.65E-10	5.87E-10	4.37E-10	2.79E-10	ke=coup/r		-2
2.7321E-12	**2.1124E-12**	**1.6313E-12**	**1.2520E-12**	**9.3263E-13**	**5.9389E-13**	**g=(939/(939+ke))**		
4.9553E+02	**4.3572E+02**	**3.8290E+02**	**3.3544E+02**	**2.8952E+02**	**2.3103E+02**	**V=(1-(g)^2)^0.5*C (m/sec)**		
4.4082E-60	2.6362E-60	1.5746E-60	9.3473E-61	5.3857E-61	2.6527E-61	F=mV^2/r (Nt)		
5.81E-10	4.49E-10	3.47E-10	2.66E-10	1.98E-10	1.26E-10	E=fdr (MeV)		6.005E-01
7.61E-02	9.83E-02	1.27E-01	1.64E-01	2.12E-01	2.75E-01	predicted r (m)		
2.162E-13	8.533E-13	3.189E-12	1.168E-11	4.241E-11	1.535E-10	e addition		0.943
9.84E+00	7.61E+00	5.87E+00	4.51E+00	3.36E+00	2.13E+00	Temp w/o star	0.354	2.85E-10
1.68E-03	6.61E-03	2.47E-02	9.05E-02	3.29E-01	1.19E+00	delta T stars	1.0075	
9.840E+00	7.613E+00	5.899E+00	4.598E+00	3.686E+00	3.324E+00	Temp with Sta	2.55E-10	
7.62E-02	9.86E-02	1.28E-01	1.66E-01	2.23E-01	3.51E-01	r=rp+(E+de)/F*1.6e-13/EXP(90)		
8.71E+24	1.13E+25	1.46E+25	1.90E+25	2.55E+25	4.01E+25	R=r*EXP(60)	with star de	
7.34E+20	4.85E+21	3.03E+22	1.87E+23	1.18E+24	8.67E+24	delta R stars		

The calculated gravitational kinetic energy is only 2e-12 MeV from inertia (not shown) but we have included photon kinetic energy 2.79e-10 MeV (associated with the temperature without stars equal to 2.3 K in the eleventh line in the table). It is clear that normal late stage expansion is mainly due to photons. The value E=Fdr=1.98e10 MeV and force 5.38e-61 Nt checks as the energy required to calculate the current radius from the prior radius.

r=rp+E/F*1.6e-13/EXP(90)			
0.275=0.86*(0.213+1.98e-10/5.386e-61*1.6e-13/exp(90))			
0.275			
3.14E+25	R=0.275*exp(60) m		
8.71E+24	delta R (4.02e25-3.14e25)		

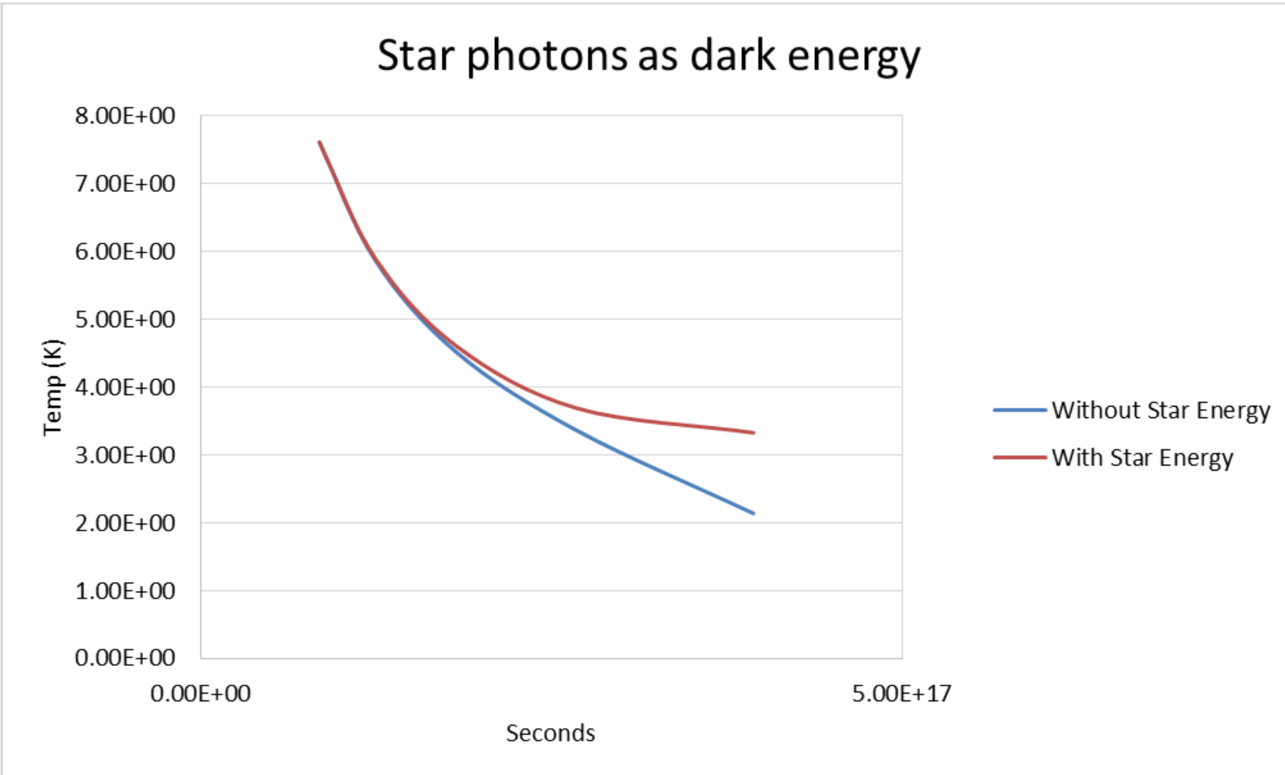
Now look at the e addition line. Adding 1.53e-10 MeV to Fdr from the prior increment increases the radius of the universe from 3.14e25 meters to 4.02e25 meters. Delta R (call it R3) was 8.71e24 meters.

R3 is compared with Cmagic and WMAP second expansion components below. The source of R3 is the row labelled "delta R" in the table above. The WMAP and Cmagic results are simulations using the procedures described in references 3,5 and 7. This delta is similar to the expansion component associated with lambda and dark energy.



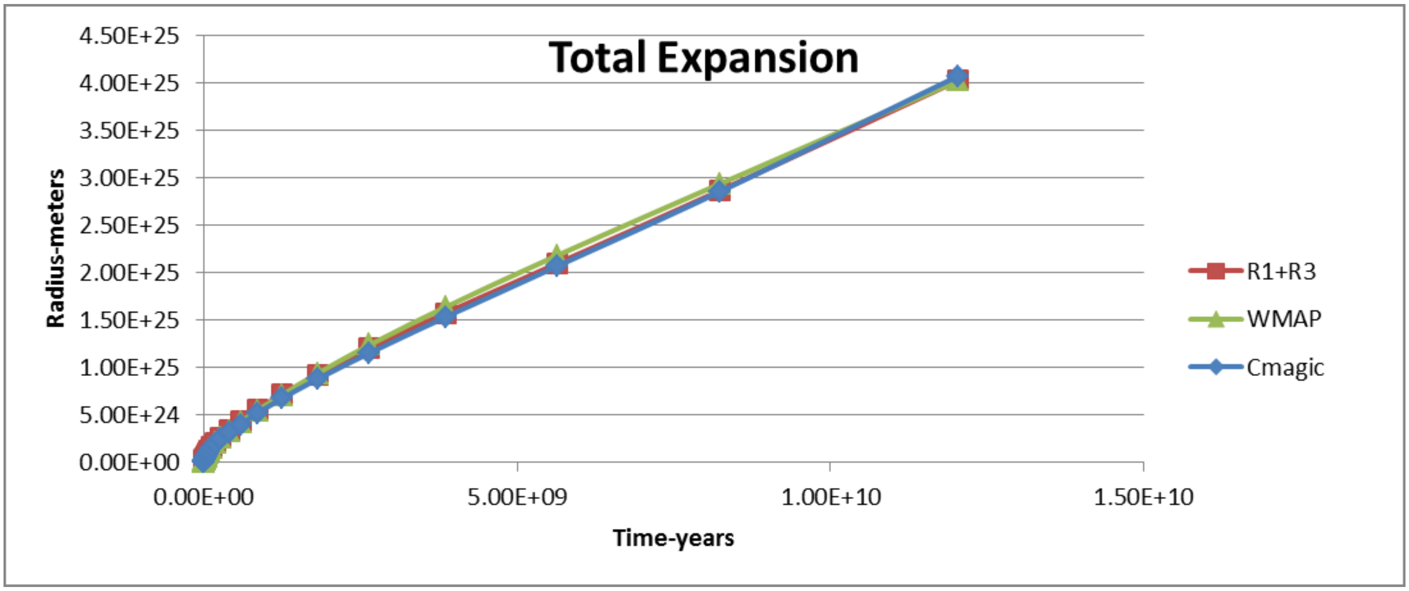
As indicated above R1 during this period of expansion is the equation R=R0*time^(2/3) but a more detailed expansion curve is presented in the section below entitled "Constructing the complete expansion curve". R3 is added to R1 expansion to reveal the total expansion. It compares favorably to WMAP [3][7] and Cmagic [5] and shows that the latter stage of expansion is flattened by energy from stars.

The effect of 1.53e-10 MeV on the temperature is a delta of 1.19 degrees K. But the calculations in the section entitled "Constructing the temperature history" indicated that the temperature dropped to 2.13 K. When you add 1.19 to 2.13 degrees you calculate temperature 3.324 K.

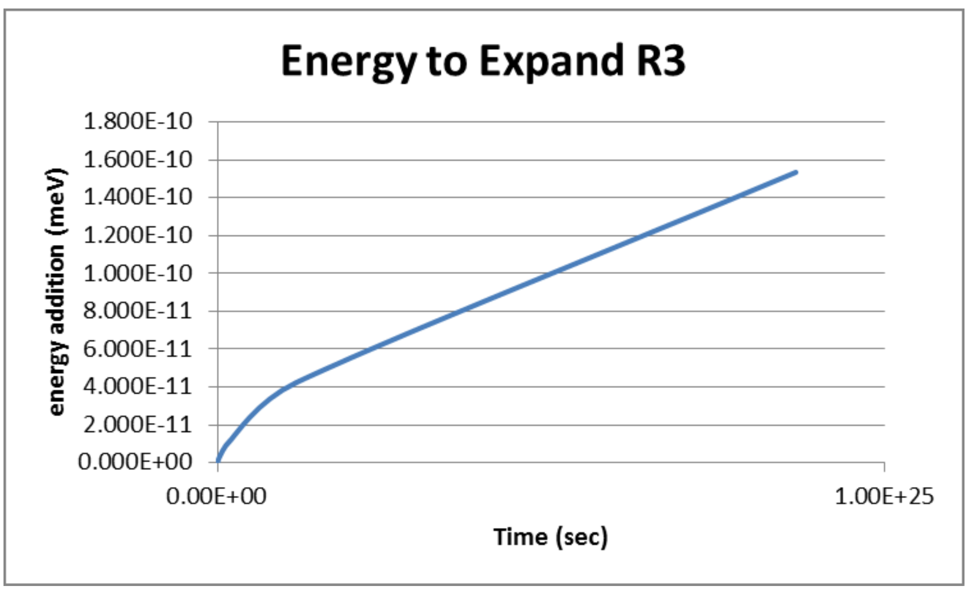


It appears to the author that WMAP measurements masked this energy source. Stars subtend a very small angle and their wavelength is very different than the CBR. Different instrumentation may be required.

The last four increments in the calculation above are enough to flatten the expansion curve and produce the measured Hubble constant of 2.26e-18/sec.



The calculation table above indicated that the force required to move particles apart against gravity is very low (on the order of 5e-61 Newtons). The energy/particle required to expand the universe from z=15 to the present is shown below.



Critical density

The standard method of simulating expansion involves the Friedmann-Lemaitre-Robertson-Walker (FLRW) model:

H^2=H0^2*(OmegaMatter*(1+z)^3+OmegaR*(1+z)^2+OmegaLambda)

Where:
OmegaTotal=1 WMAP result
Rhoc=H0^2/(8/3 pi G) (critical density)
OmegaR(1+z)^2=0 (wrong shape)
OmegaMatter separated into =Omega cold dark matter and baryons
OmegaLambda is the cosmological constant
H0=2.26e-18/sec WMAP 9 year result
z=(r/rf-1) where radius is the developing radius and rf is the final radius.

G		6.67480E-11			
Ho		2.26E-18			
rhoC	8/3 pi G/Ho^2	9.124E-27	2.26E-18^2/(8/3*PI()*6.674e-11)		

WMAP Review:

WMAP results [12] are important to cosmology. They support the existence of dark energy and are widely quoted for the discovery that most of the expected matter in the universe is missing. The current photon number density is well established by the Temperature 2.73 K.

The updated year 9 parameters are shown in table below entitled WMAP published.

WMAP [7]			
NOW			
published			
4.02E+25	Inferred Radius		
2.26E-18	H0		
8809	Temperature at equality (K)		
	Photon mass density		
	Proton mass density		
2973	Temperature at decoupling (K)		
0.0106	Spot angle (radians)		
0.254	baryon number density		
5.77E+08	Photon number density		
4.400E-10	baryons/photon		
0.235	Dark matter fraction		
6.57E-27	dark matter density in kg/m^3		
4.2377E-28	baryon matter density in kg/m^3		
0.719	Dark energy fraction		
9.1351E-27	critical density		
0.0464	Baryon fraction		

Some have called the value 0.0464 the "missing matter (baryon)" problem. Values similar to this have been reported in various documents over a period of many years. Limitation of this value in the literature is due to 1) deuterium residual measurements 2) position and time duration of the period equality and decoupling 3) photon/photon ratio required to produce He4 reactions 4) analysis of peaks and valley in micro-degree peaks in CBR anisotropy and the misleading FLRW model. Reference 20 addresses these limitations and concludes that 0.5 normal and 0.5 dark matter fraction of critical density is acceptable.

Recalculating parameters with 0.719 dark energy removed

Energy from star photons causes late stage expansion but the standard equation becomes very misleading because rhoC assumes that all expansion is density driven. The critical density concept presented in the literature (density is related to kinetic energy using the Friedmann derivation) assumes that initial kinetic energy drives all of expansion but we found that energy was added at 3 places. This means that expansion is only partially density driven and we must separate the causes of expansion and treat them differently. Above we showed that energy addition on the order of 2e-10 MeV was equivalent to 0.719 critical density (dark energy). We can compare these going back to the Friedmann derivation for critical density.

	substituting to give rho
ke	pe
1/2Mv^2	Fr
1/2Mv^2	GMM/r
ke/M	pe/M
1/2v^2	GMMr^2/r^3)/m
	GMr^2/r^3)
	4/3*Gr^2(M/(4/3*pi r^3))
1/2 v^2	(4/3 pi G rho) r^2
v^2	(8/3 pi G rho) r^2
v/r=H	(8/3 pi G rho)^.5

	H=(8/3*PI()*0.0000000000667*9.14E-27)^0.5			
v/r=H	2.25993E-18	1/sec		
v=v/r*R	9.08493E+07	m/sec with R=4.02e25 m		
ke=1/2*mv^2	43.0	mev		

Critical density converted to kinetic energy is 43 MeV. But we found that we needed only 3e-10 to expand in the second component. They use 0.719*43=31 MeV but this is 11 orders of magnitude too high.

Cosmological parameters with dark energy removed (and replaced with star photons) are shown below. The table also corrects the baron fraction of critical mass from 0.046 to 0.5. Critical density takes on the meaning “current density”.

WMAP [4]			R1+R3	R1+R3	R1+R3
NOW			equality	decoupling	NOW
published					
4.02E+25	Inferred Radius (m)		5.40E+21		4.02E+25
				R1	3.14E+25
2.26E-18	H0				
8809	Temperature at equality (K)			31584	
	Photon mass density				
	Proton mass density				
2973	Temperature (K) decoupling			2643	
0.0106	Spot angle (radians)			0.0107	
0.254	baryon number density				2.737
5.77E+08	Photon number density				5.77E+08
4.400E-10	baryons/photon				4.75E-09
0.235	Dark matter fraction				0.500
6.57E-27	dark matter density in kg/m^3				4.57E-27
4.24E-28	baryon matter density in kg/m^3				4.57E-27
0.719	Dark energy fraction				0
9.14E-27	critical density				9.14E-27
0.0464	Baryon fraction				0.500
2.72E+77	Overall volume (m^3)			6.60E+65	2.72E+77
2.814E-01	overall mass density			rhoC	Volume
				9.135E-27	2.72E+77
				rhoC*Volume	exp(180)
				1.484E+78	1.489E+78
				mass (Kg)	2.4873E+51

Number of proton like masses in the universe

We can now calculate the number of proton like masses in the universe. The critical density 9.14e-27 kg/m^3 is baryons plus dark matter. The current radius R1+R3 is 4.02e25 meters and this gives 2.72e77 meters^3. Multiplying critical density by volume gives the number of proton like masses in the universe. This means that the total proton like masses in the universe is exp(180). We do not know if dark matter has a proton like mass but this is an interesting number to the author because exp(180) was the starting point for a unifying theory [1][2][appendix 1].

rhoC	Volume	rhoC*Volume	exp(180)	rhoC*V/exp(180)
9.135E-27	2.72E+77	1.49E+78	1.49E+78	1.000

Some details of the WMAP parameters are compared below with the revised parameters presented in the rightmost column.

Conclusions

There are several areas that need reconsideration if we can agree that energy produced by stars is the cause of late stage expansion. Calculations indicate that the later part of the expansion curve is flattened by this energy and agrees with simulated expansion curves reported in the literature. The concepts of “dark energy” and missing matter were a concern. The source for star energy caused expansion is fusion and on this basis I believe that “dark energy” has been identified. But this energy is not the kinetic energy of protons and as such the reported densities must be revised. The revised baryon content of the universe is 0.5 fraction of final density, not 0.046 as reported by WMAP.

Possible objections to revised cosmological parameters were addressed in Reference 20. New calculations were carried out regarding the residual abundance of He4, He3, Deuterium and Li7. The calculated values match the measurements if two changes in the calculations are made. One change is the increased radius to enclose He4 reactions (20) the second change is the revised baryon content 0.5.

The author found an energy value in a model of the proton that is important to cosmology. The initial kinetic energy is 10.15 MeV. Combined with new concepts for quantum gravity a complete expansion curve was constructed. The expansion curve has several stages and agrees with data available. Specifically, Hubble constant 2.26e-18/sec is satisfied by a final radius (including all components) of 4.02e25 meters. The expansion radius calculated for the main component (R1) of expansion is 3.21e25 meters. Late stage star energy caused expansion 3.21e25+7.96e24=4.02e24 meters at the current time in expansion.

The proton mass model proposed by the author starts with exp(180) particles of proton like mass. The model is strongly supported by the analysis presented.

References

1. Barbee, Gene. H., *A Top-Down Approach to Fundamental Interactions*, FQXi essay June 2012, viXra:1307.0082, Nov 2014
2. Barbee, Gene. H., *Unification*, viXra:1410.0028, Oct 2014.
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, Gene H., *On the Source of the Gravitational Constant*, Prespacetime Journal, Volume 5 No 3, April, 2014. Originally viXra:1307.0085.
7. Hinshaw, G. et.al, Nine Year WMAP Observations, draft June 5,2013 http://arxiv.org/pdf/1212.5226v3.pdf Table 2.
8. Bergstom, L. and Goobar, A., *Cosmology and Particle Astrophysics*, 2nd Edition, Springer-Praxis Books in Astrophysics and Astronomy, 2004.
9. Barbee, Gene H., *The Effect of He4 Fusion on Primordial Deuterium*, viXra:1404.0465, May 2014.
10. Barbee, Gene H., *Application of Proton Mass model to Cosmology*, viXra:1307.0090, Jan 2015.
11. Barbee, Gene H., *Semi-Fundamental Abundance of the Elements*, viXra:1308.0009
12. http://cds.cern.ch/record/262880/files/940501.pdf Review of work by N. D. Schramm.

13. Barbee, Gene H., *Discovery of Quantum Gravity*, viXra:1508.0120, Aug 15 2015.
14. Barbee, Gene H., *Nature and Information*, http://www.vixra.org/pdf/1611.0302v1.pdf, December 2016. http://prespacetime.com/index.php/pst/issue/view/91
15. Barbee, Gene H., *On Expansion Energy*, *Dark Energy and Missing Mass*, Prespacetime Journal Vol. 5 No. 5, May 2014. Previously vixra:1307.0089, revised Mar 2014.
16. Barbee, Gene H., *A Simple Model of Atomic Binding Energy*, vixra:1307.0102, revised Feb 2014. Reference spreadsheet atom.xls.
17. Barbee, Gene H., *Semi-Fundamental Abundance of the Elements*, vixra:1308.0009, revised June 2014.
18. http://cds.cern.ch/record/262880/files/9405010.pdf
19. Patrick Peter, Jean Philippe Uzan, Primordial Cosmology, OUP Oxford, Feb 14,2013.
20. Barbee, Gene H., *Dark Matter and the Cosmic Web*, viXra:1701.0503v1, January 2017.

Appendix 1: Proton mass model

The formal definition of information is attributed to Claude Shannon [7]. Information (N) = -ln P (Inversely, P=1/exp(N) where exp(N) means the natural number 2.718 to the power N). Probabilities are the chance of one event divided by all possibilities. He used natural logarithmic relationships because probabilities (P) multiply but information is additive. The negative sign tells us that information is high when probabilities are low.

Can energy (E) be related to information? Using the right probability, the answer is yes. Probability P=e0/E where e0 is an energy constant that forms an energy ratio. Quantum mechanics deals with the square root of P (a complex number called psi). This is tied to wave/particle duality but the relationships of interest are described by probability P=e0/E=1/exp(N) and E=e0*exp(N).

N for fundamental energy values

The relationship E=e0*exp(N) will be used extensively. N is a logarithmic number. The key to N values for energy was correlation of data gathered by high energy labs [3][7]. Comparing N values for particles and knowing that the 0.511 Million Electron Volts (MeV) electron has a field equal to 2.72e-5 MeV, allowed the author to deduce that the electron N was 10.136 and its electromagnetic field energy N was 0.296=3*0.0986=3*ln(3/e) where e is the natural number 2.718. The energy constant e0=2.02e-5 MeV is calculated below from Particle Data Group [3] data for the electron mass. The universal equation for energy is E=2.02e-5*exp(N) MeV.

Electron N	**10.136**	**(10.3333-0.0986*2)**			
Electron mass (mev)		**mass of electron (MeV)**	**0.51100024 MeV**		
Find the value e0 by solving the above equation with E=.511				**e0=E/exp(N)**	
				e0= 0.511/exp(10.136)	
				2.025E-05	**mev**
Note that 3*.0986=.296			**E=eo*exp(.296)=2.72e-5 mev**	**2.722E-05**	**mev**
The electric field energy of the electron is known to be: (MeV)				**2.72E-05**	**mev**

Data showing an N value for fundamental energy observations is listed in Part 2 Topic 1. The data is from either from NIST, (National Institute of Standards and Technology), the Particle Data Group [5] maintained by UC Berkeley or other reported values [3][7]. There are three quarks confined in a neutron (and proton) but they are not observed individually. The higher energy bosons are variations of N=22.5 and the Higgs particle measured in July 2010 agrees well with the author's N value of 22.575. Time for fundamental particles is simply reciprocal time (1/time=frequency).

Neutron components

The author found N values for neutron components based on the way three quark masses and their kinetic energies add to the neutron mass. The related information components total N=90 for the neutron. They are listed in Table 1 below.

	Neutron particle and kinetic energy N		Neutron field energy N	
Quad 1	**15.43**	quark 1	**17.43**	strong field 1
	12.43	kinetic energy	**10.43**	gravitational field component
Quad 2	**13.43**	quark 2	**15.43**	strong field 2
	12.43	kinetic energy	**10.43**	gravitational field component
Quad 3	**13.43**	quark 3	**15.43**	strong field 3
	12.43	kinetic energy	**10.43**	gravitational field component
Quad 4	**10.41**		**-10.33**	
	-10.33		**10.41**	gravitational field component
Quad 4'	**10.33**	pre-electron	**10.33**	
	0.00		**0.00**	
	90.00	Total	**90.00**	Total
	Table 1		Table 2	

Table 2 is similar to Table 1 except it contains N values for field energies of the neutron. Since the neutron does not carry charge, the electromagnetic field is absent but appears as a separation once the neutron decays to a proton (quads 4 and 4'). The strong residual field energy is part of a total energy balance. Sets of four N values labelled quads are involved in an information operation.

Table 1 represents mass plus kinetic energy and Table 2 represents field energy. Set 2 will be used as an example for a quad that contains four values. The N values 13.43+12.43 are separated into 15.43+10.43. This operation conserves N but energy is also conserved. After these operations mass is imbedded in field energy quantum orbits. Each N has a specific place and a specific energy described below. N1 always gives a mass, N2 always represents a kinetic energy value, N3 always specifies strong field energy and N4 always specifies a second field energy (associated with gravity).

E1 will be identified as a mass (a quark for the strong interaction)
E2 is identified as a kinetic energy (ke) addition to energy E1.
E3 is identified as strong field energy.
E4 is identified as a gravitational field energy component.

		mev			mev		
		E=e0*exp(N)			E=e0*exp(N)		
N1	13.432	13.797	E1 mass	N3	15.432	101.947	E3 field
N2	12.432	5.076	E2 ke	N4	10.432	0.687	E4 field

These above energy values are placed in a table below with mass plus kinetic energy (102.634 MeV) separated from field energy (102.634). The total energy across the interaction is conserved at zero with mass (E1) + ke (E2) +ke difference (E4+E3-E2-E1) balancing field energies (E3+E4 shown as negative). This information separation followed by energy conservation has powerful implications. The operation involving E1 and E2 can be read E1 is given exp(2) of kinetic energy. Since the numbers (N) are exponents (E=e0*exp(N)), the number 2 can be associated with a divisor 1/exp(2)=0.135 that increases the kinetic energy of E1. The value 0.135 is identical to the concept of gamma in relativity. Gamma is the divisor that increases the kinetic energy of a moving mass involved in the Lorentz transformation. The definition is: ke=m/gamma-m. These may be special case Lagrangians and the energy interaction is similar to a physics qauge transition.

Information (N) values from the neutron component table were used to a model the neutron's known mass, 939.56 MeV. Three quads of N values are associated with three quarks and the fourth set transitions to the electron. The values toward the left side of the box, labeled mass and kinetic energy are balanced by fields on the right hand side of the box. Fundamental N values (13.431, 12.431, 15.431 and 10.431) are shown to the left of the box. These values are the source of the energies (E=e0*exp(N)) inside the box. The kinetic energy operator N=12.431 gives mass kinetic energy. It's associated energy=2.025e-5*exp(12.431)=5.01 MeV. This creates a quark orbit with kinetic energy and associated field energies. The kinetic energy column has several components. Kinetic energy for each quad =E3+E4-E1-E2-E2. The extra E2's are added back to form the column weak kinetic energy (10.15 MeV) and gravitational expansion energy (20.3 MeV). These energies play crucial roles in cosmology. The bottom quad is for the electron after it has decayed from the neutron.

Tables 1 and 2 above each sum to the value N=90 but are separated opposites. This separates zero energy into two types of energy. Mass plus kinetic energy is positive and field energy is negative. The total energy for each neutron (939.56 MeV) plus the external kinetic energy that drives expansion is 960.54 MeV but the fields are negative 960.54 MeV. This conserves the other initial condition; zero energy.

Energy (MeV) = 960.54-960.54=0.

CALCULATION OF PROTON MASS				Mass and Kinetic Energy					Field Energies	
mass	Energy	strong fiel	Energy	Mass	Difference	Strong residual	Neutrinos	Expansion	Strong & E	Gravitatior
ke	MeV	grav field	MeV	MeV	MeV	MeV	MeV	MeV	field energ	Energy
15.432	101.947	17.432	753.291	101.95	641.88				-753.29	
12.432	5.076	10.432	0.687							-0.69
13.432	13.797	15.432	101.947	13.80	78.69				-101.95	
12.432	5.076	10.432	0.687							-0.69
13.432	13.797	15.432	101.947	13.80	78.69				-101.95	
12.432	5.076	10.432	0.687					10.151	expansion	-0.69
		-0.296	-2.72E-05			10.15		10.151	expansion ke	
		equal and opposite charge					0	v neutrino m		
-10.333	0	-10.333	0	0	-0.67		0.67	v neutrino	0.00E+00	
10.408	0.67	10.408	0.67				0.67	t neutrino	-0.62	-0.67
the electron separates here				129.54	798.58	**938.272014**	**PROTON MASS**			
10.136	0.511	10.333	0.622	**0.511**	0.111	0.622	Electron + ke		0.000	
0.197	2.47E-05	0.296	2.72E-05	**ELECTRON**			7.40E-05	e neutrino ke		
90	sum	90	sum				1.342	20.303	-957.807	-2.732
								Total m+k	Total fields	
								Total posit	Total negative	
								960.539	-960.539	0

Values from the proton model unify the four forces (interactions) of nature [2].
One important value above is 20.3 of expansion potential energy that forms an orbit with about 10.15 MeV of kinetic energy and 10.15 MeV of potential energy. A neutron falls into the 2.723 MeV gravitational field and establishes an orbit at 7.22e-14 meters. This physics is the same as General Relativity except it occurs at the quantum scale. Another value of interest above is the difference between the neutron and proton mass, 1.293 that is made up of a neutrino of energy 0.671 and an electron with kinetic energy of 0.662 MeV.

Appendix 3: Review of cellular cosmology

Consider large mass M (for our purposes the mass of the universe although the term universe seems a little presumptive) broken into exp(180) small cells, each with the mass of a proton labelled lower case m below. The mass (m) of a proton is 1.67e-27 kg. Fill a large spherical volume with exp(180) small spheres we will call cells. The value exp(180) comes from the section below entitled “Number of proton like masses in the universe”. Consider the surface area of many small cells as a model of the surface of one large sphere with the same surface area. For laws of nature 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 surface model equivalent to the surface of many small cells is useful if the fundamentals of each cell are known.

In general relativity [6] the metric tensor (scholarly matrix equations from general relativity) is based on (ds^2=three distances^2 and (C*time)^2). Note that ds^2 is a surface area and it is this surface that we will break into the surface area of exp(180) small spheres. Let small r represent the radius of each small cell and big R represent the radius of one large sphere containing exp(180) cells with the same surface area. 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 small cells but we will use similar substitutions to evaluate other forces.

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 (lower case r,v and m below are for cellular space):

At any time during expansion		
Large space		**Cellular Space**
		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)**

The extremely small value 1/exp(90) is the coupling constant for gravity. When measurements are made at the large scale as must done to measure G, the above derivation indicates that we should multiply cell scale values (r*v^2/m) by 1/exp(90) if we expect the same G. Geometric and mass relationships give the cell "cosmological properties".

The procedure applied to the force equation F=MV^2/R yields the same result by applying substitutions that represent the relationship between one cell and the universe.

Appendix 4: Calculation of Gravitational Constant from the Proton Mass Model

Using values for the proton mass model that the author believes unify nature's forces (6), the gravitational constant is calculated below and agrees with the published constant, G=6.674e-11 N meters^2/kg^2.

The following table follows a format that organizes input values, intermediate results and the final result in a column of calculations. The goal is to use the fundamental radius 7.224e-14 meters to calculate the gravitational inertial force. The inputs listed at the top of the table originate in the neutron model above. Firstly, the mass of a proton in MeV and its mass in kg are specified in the table. The gravitational field energy 2.723 MeV gives R=7.224e-14 but there is kinetic energy (10.14 MeV) in the orbit that the neutron falls into. With mass and kinetic energy, gamma and V/C can be calculated. Next the inertial force is determined for the mass orbiting at radius R.

			GRAVITY
			mass only
GRAVITY			
			neutron
Neutron Mass (mev)			**939.565**
Neutron Mass M (kg)			**1.675E-27**
Field Energy E (mev)			**2.732**
Kinetic Energy ke (mev)			**10.140**
Gamma (g)=M/(M+ke)			**0.9893**
Velocity Ratio v/C=(1-g^2)^0.5			**0.1457**
R (meters) =(HC/(2pi)/(E*E)^0.5			**7.224E-14**
Inertial Force (F)=(M/g*V^2/R)*1/EXP(90) NT			**3.627E-38**
HC/(2pi)=1.97e-13 mev-m			
Calculation of gravitational constant G			
G=F*R^2/(Mn/g*Mn)=NT m^2/kg^2			**6.6743E-11**
Published by Partical Data Group (PDG)			**6.6743E-11**

The measured gravitation constant G [16] is calculated above from fundamentals. The constant 1/exp(90) scales the quantum level to the large scale we observe around us. It has the effect of dramatically reducing the force between neutrons and makes gravity very long range compared to the other forces. The inertial force 3.66e-38 N is the same force as the literature above and confirms the radius 7.22e-14 as the radius for quantum gravity.