Expansion Kinetic and Potential Energy
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Abstract

The Wilkinson Microwave Anisotropy Probe WMAP [3][7] and similar projects led to expansion curves and cosmological parameters that are becoming generally accepted. The author developed expansion equations that agree with WMAP but are thought to be more fundamental. A unique cellular approach is used that allows the kinetic energy and potential energy to be calculated. There are two components of expansion and the second component is late stage expansion and according to calculations requires negligible kinetic energy. However the concept of critical density (H= (8/3 pi G rhoC)^.5, where rhoC=9.5e-27 mev/m^3) assumes that this kinetic energy is high, therefore omega dark is near zero. Critical density (omega total=1) according to year 9 WMAP parameters [7] is composed of fractions: omega dark=0.718, omega mass=0.235 and omega baryonic mass=0.046. One goal of this paper is to reanalyze mass components using nil omega dark.

Based on a model of the proton [1], the author uses 9.8 mev as the kinetic energy of expansion and it appears to be just adequate and is converted to 9.7 mev of potential energy late in expansion. This is associated with a surface temperature of (7.6e10 K=9.8/(1.5 B) with B= Boltzmann constant. At the end of expansion, the kinetic energy related temperature would be 0.01 K, not the measured value 2.725K. Primordial nucleosynthesis releases 0.23*7.07=1.61 mev. When this energy is added to the kinetic energy, the CMB temperature agrees with observations. Also, neutrons decay with a half-life of 886 seconds releasing 1.29 mev of neutrinos and the electron. This is associated with a temperature at the end of expansion that is 1.39 times the photon only temperature. This photon density allows more baryon density while maintaining the important 6e-10 baryon/photon ratio. The 6e-10 baryon/photon density is equivalent to 0.5*exp(180) protons/m^3 indicating that one half of the mass is protons and the other half is cold dark matter. Although the author does not have access to the original data and analysis tools, it appears that the zero dark energy critical density (2.1e-27 kg/m^3) is one half protons.

Detailed reanalysis of the critical transitions called equality and decoupling were carried out showing that the measured CMB spot size data and temperature variation matches calculations if equality occurs at 1.35e22 meters (1.5e5 years).

Overview

It is generally accepted that expansion involves the conversion of kinetic energy to potential energy. In the derivation below Mu (mass of the universe) is the total mass and rho is the density at each point in the expansion. The result is for expansion of a small cell, labeled r that is duplicated exp(180) times to fill the overall volume. The model is described in reference 1 and reference 6 but is summarized in Appendix 1 for convenience. Using a small cell of radius r to evaluate big R (literature would call this

the radius of the universe) is critical to understanding cosmology. In this model, the universe is filled with the *surface* of many small cells and this is equivalent to the *surface* of one large sphere. This is important conceptually because we can be inside the universe (something we all observe) and each surface can be identical (a critical understanding of cosmology is that there is no preferred location). There is a numerical and geometrical relationship between many small cells and one large sphere that requires the geodesics of cells to be multiplied by the small factor 1/exp(90), a value that the author shows is the gravitational coupling constant [1][6]. Appendix 3 familiarizes the reader with gravitational theory based on the cellular model.
Expansion of each cell involves kinetic and potential energy changes that exactly balance with one proton on the surface of each cell. Expansion is driven by kinetic energy in the form of temperature (and pressure). Initially there is no energy difference between cells but after expansion, potential energy allows cells to fall (accelerate) toward each other.

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

Derivation showing that r expands as t^(2/3)
Mu=rho*4/3*pi()*R^3=rho*4/3*pi()*r^3 exp(180)
R^3=r^3*exp(60)^3
r^3 increases as t^2 (will be time^(2/3) in next step)
R^3=(r)^3*t^2*exp(180)
R=r*t^(2/3)*exp(60)
r=k/(EE)^).5=1.93e-13/(2.683*2.683)^.5=7.35e-13
R=(7.35e-13)^3*t^(2/3)*exp(60)
R=(7.35e-13)*t^2/3*exp(60)
v=H*R where H is Hubble's constant
dR=H*R*dt (dt=alpha dg)
g is a time ratio= time/alpha time
dR=H*alpha*R *dg
int (7.35e-13)*g^2/3*dg =Rf-7.35e-13*g^2/3
Rf=(7.35e-13)*g^(2/3)+(7.35e-13)*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 [3][5]. The cosmological constant adds a late stage 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 that characterize expanding cells. Each cell radius is related to bigR by the relationship R=r*exp(60). The author also prefers making time a dimensionless ratio, g=time/alpha. The full expansion equations are shown below in the heading "Making cell size space into universe size space".

Identifying small r and time ratio g in the expansion equation

Fundamental radius

The energy 2.683 mev underlies the quantum mechanics for fundamental radius r and time. This energy is found in the proton mass model [1] associated with gravitation and included in Appendix 2.

Gravitational Action			E	2.6831E+00	mev
			const HC/(2pi	1.97E-13	mev-m
			R=const/E	7.3543E-14	m
			t	1.54135E-21	sec
			Field side	R side E'=m/g	
	E=Hv		H/E	2*pi*R/V	
	t=H/E=2piR/V		1.541E-21	1.541E-21	sec
			1.54135E-21		
1		qm test	m/c^2x^2/t	6.5821E-22	mev-sec
		qm test/h	m/c^2x^2/t/h	1.00	

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

r=1.973e-13/(2.683*2.683/1)^.5=7.35e-14 meters.

Fundamental time

Identify the fundamental unit of time for expansion is the gravitational orbit described above/(time around radius)						
	Fundamental radius=1.93e-13/(2.68*2.68)^.5=7.354e-13					
	Fundamental time=7.354e-14*2*PI()/(3e8)=h/E=4.13e-21/2.68					
	Fundamental time	1.541E-21	seconds			

Define alpha as initial time. The ratio g=time/alpha is the parameter in expansion equation, i.e. R=r*g^(2/3).

Identify alpha based on Reference 1 and WMAP best fit				
	dimensionless time			
	1/exp(45)	2.863E-20	sec	
	alpha=fund time/dim time=1.54e-21/2.86e-20			
	alpha	0.0538	sec	

Find expansion constant H1:

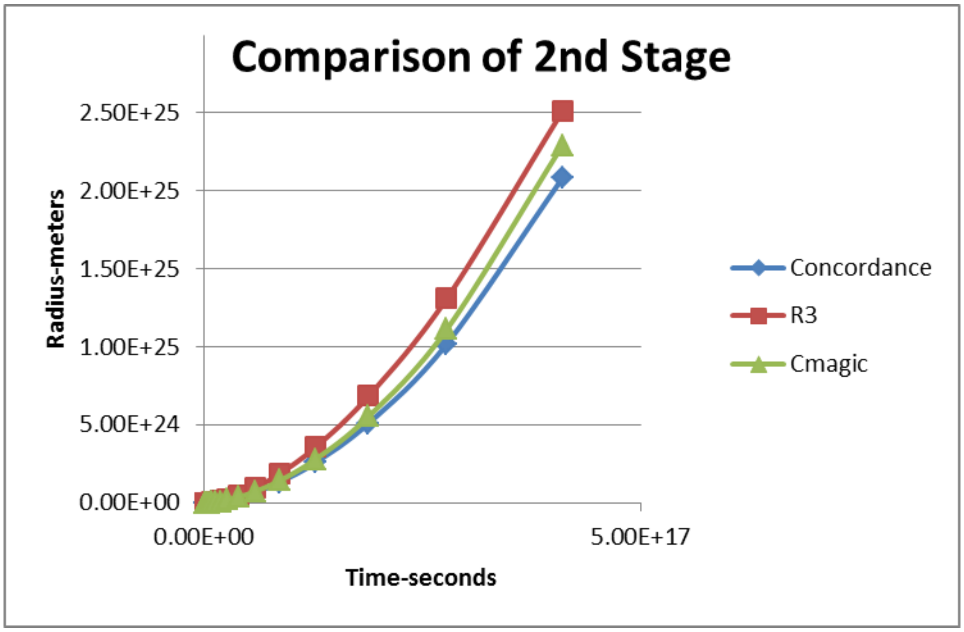
The expansion model will be called the "R1+R3" expansion model, with components R1 and R3.

R1+R3=7.35e-14*g^(2/3)+7.35e-14*g^(5/3)*H1*alpha/1.66

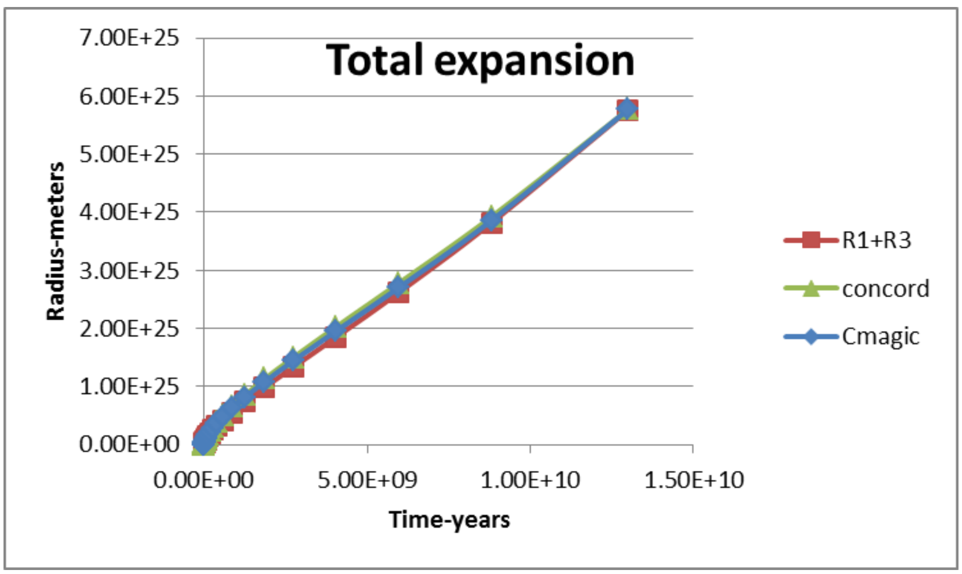
Note in the equation above that there are no unknowns in the equation R1=7.35e-14*g^(2/3) but the second part R3=7.35e-14*g^(5/3)*H1*alpha/1.666 contains alpha and one unknown, H1. Alpha is known but H1 must be evaluated and compared with WMAP and CMagic correlations for the second component. Time of expansion is alpha*g and in the range of 14 billion years, we look at H1. A "Hubble's constant" H1 can be calculated for R3 expansion only and its value is 3.1e-18/sec. If this value is used as the unknown H1 the resulting expansion curve compares favorably with both the WMAP concordance model and the Cmagic model. Using these values the equation for R3 is: R3=7.35e-14*g^(5/3)*3.14e-18*0.053/1.666.

R is calculated with increasing g until overall H is 2.26e-18 [7]. The match gives R1+R3= 5.8e25 meters at 4.1e17 seconds (13 billion years). R3 is 0.44 of the total radius but of course expanding faster (power is 5/3).

Expansion Comparisons



The R1+R3 model can be compared with the concordance and Cmagic models.

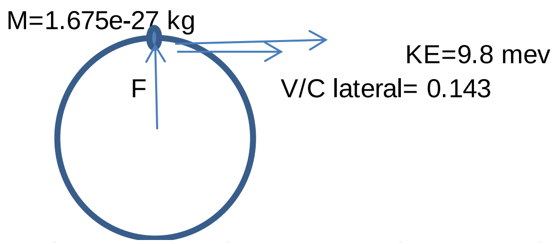


Gravity in expanding space

In large space the Newtonian equation F=GMM/r^2 gives the force between objects. For example two particles of mass 938.27 mev (1.67e-27 kg) gives F=6.67e-11*(1.67e-27)^2/(7.35e-14)^2=3.46e-38 NT. Gravitation at the cellular level is described in reference 1 and 6. Note the equation below for the same force involves the small factor 1/exp(90). Reference 1 indicates that this is the coupling constant for gravity.

Cell size space

The following diagram is the initial radius of one cell. The orbital kinetic energy (9.8 mev) causes lateral velocity V/C=0.147. (Lateral because we are dealing with surfaces).



Source of Gravitational Constant G

The values in the following table are believed to be the source of gravitation [1][6] at the cellular level:

			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=HC/(2pi)*(E*E)^.5			**7.3543E-14**
Inertial Force=(M/g*C^2/R)*1/EXP(90) NT			3.4524E-38
HC/(2pi)=1.97e-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			6.67428E-11
			6.67428E-11
PE fall			19.34
KE orbit			9.720
F (NT) =PE/R=19.34*1.603e-13/7.3543e-14			3.4524E-38

Cell size space expands to universe size space

Expansion is outward in the diagram above and is caused by expansion kinetic energy but modelled as a function of time. The universe will be considered as expanding cells with a proton on each surface. Using WMAP data, reference 1 estimated that there are approximately exp(180) protons. 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 cellular level. Also, expansion is subluminal making calculations possible.

Orbital kinetic energy decreases 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.

Expansion Discussion

The cellular model defines space, time, expansion, kinetic and potential energy. The model's geometrical and numerically similarity allows many small cell surfaces to represent one large surface. It identifies an orbit that maintains gravity at G. The "orbit" is again a model since it is temperature and pressure associated with kinetic energy that drives expansion. The source of the expansion energy is the proton model described in reference 1. The model shows protons with about 20 mev that fall into "orbits" with 9.8 mev of kinetic energy and 9.8 mev of potential energy. Initially the proton on the cell surface has high velocity (0.14C) that gives an outward inertial force equivalent to gravity. During expansion initial lateral velocity is converted to potential energy while geodesics are maintained in a way that the gravitational constant remains the same throughout expansion. Particles that subsequently fall into orbits as mass accumulation occurs often have kinetic energy/particle on the order of several mev, supporting the initial kinetic energy value. 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.

Expansion Table (first 3 time steps)

The following table puts the derivations above into action. There are many results in tables below for R1+R3 expansion. The simulation starts at the fundamental radius and progresses to the right as time advances. The author uses a natural logarithmic scale starting at 45 with time=exp(45+c)*1.54e-21 seconds. Dimensionless time (g) = time/0.0583 starts with 1. If c above is a small value, the model contains more incremental steps. There rows in the model contain values of interest. Cell radius is R+R3, using the derivation above. Runiverse = (R1+R3)*exp(60). Ke orbit=9.78*7.35e-14/(R1+R3). Gamma=938.27/(938.27+ke). V/C=(1-gamma^2)^.5. Fgravity=M*V^2/(R1+R3)/exp(90), where M=1.67e-27 kg. G=F/M^2*(R1+R3)^2/exp(90) and note that the calculated gravitation constant G is constant throughout expansion (this does not change gravity since it is fixed at the fundamental cellular level). The highlighted rows are kinetic energy and potential energy. Potential energy=PE+F*(delta R)/2*6.24e12 mev/(nt-m). Potential energy is integrated by adding the PE for the calculation increment to the previous PE.

					cells hidden
alpha (initial time in sec)		0.0538	Start	45=LN(0.0538/1.54e-21)	
logarithm used to increase time (LN)			45	45	45.24455
time--seconds		EXP(LN)*1.54e-21		0.053845966	0.069
		1.54E-21	1.54E-21	1.54135E-21	1.54E-21
g time ratio	1	time/alpha	1	1	1.28E+00
		2 pi R/C	1.54E-21	1	2
Cell radius	7.35E-14	R=R1+R3	7.35E-14	7.35E-14	8.66E-14
1.358E-18		R1	7.35E-14	7.35E-14	8.657E-14
		R3	7.35E-14	6.54E-33	9.83E-33
R universe	5.773E+25	(R1+R3)*exp(60)	8.40E+12	8.40E+12	9.89E+12
				0	3.05E+07
	938.27	mass mev	938.272	938.272	938.272
0.987	0.9897	gamma (g)	0.9897	0.9897	0.9912
ke orbit	9.781	mev	9.78	9.78	8.31
V/C orbit	0.1433		0.1433	0.1433	0.1322
velocity	3.00E+08	m/sec	4.30E+07	4.30E+07	3.96E+07
Fgravity (nt)		F=M V^2/R/exp(90)	3.44E-38	3.44E-38	2.49E-38
G at end	6.6743E-11	G=rV^2/M/exp(90)	6.57E-11	6.64E-11	6.66E-11
Fi=MV^2/R/exp(90)		1	3.474E-38	3.438E-38	2.487E-38
Pe=Pe+dPE=Pe+Fi dR/2			0	0.00E+00	1.45E+00

Expansion table (last few time steps)

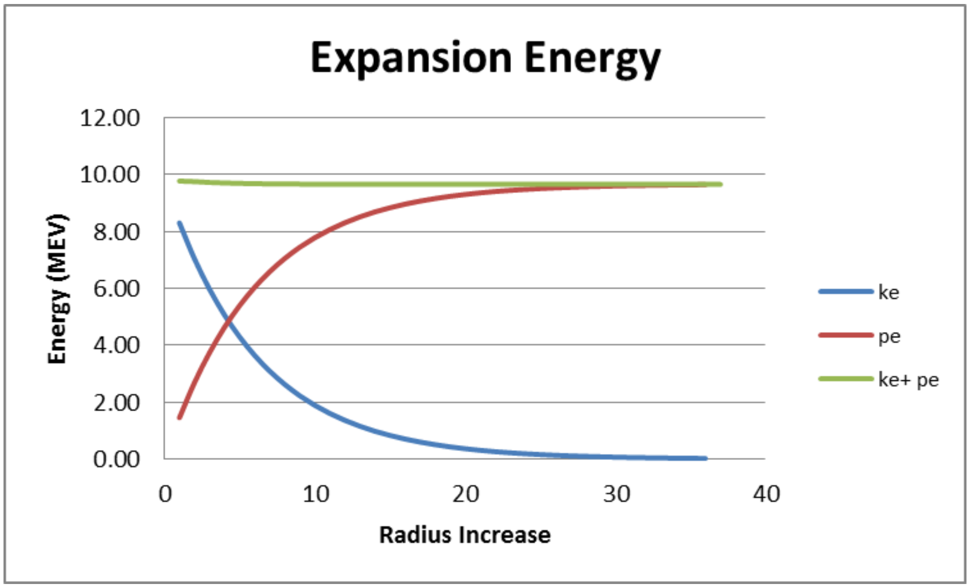
R universe is estimated to be about 5.79e25 meters at 14 billion years. The two components are labelled R1 and R3 below. When the slope of the integration ends we would look for H to be the measured value 2.26e-18/sec [7]. It does in the calculation shown below.

					cells hidden	cells hidden				
alpha (initial time in sec)	0.0538		Start	45=LN(0.0538/1.54e-21)		Last few steps		NOW		
logarithm used to increase time (LN)			45	45	45.24455	88.0408	88.28535	88.5299	88.77445	90
time--seconds		EXP(LN)*1.54e-21		0.053845966	0.069	2.65E+17	3.39E+17	4.32463E+17	5.52E+17	1.88107E+18
		1.54E-21	**1.54E-21**	1.54135E-21	1.54E-21	1.54E-21	1.54E-21	1.54135E-21	1.54E-21	1.54135E-21
g time ratio	1	time/alpha	1	1	1.28E+00	4.92E+18	6.29E+18	8.03148E+18	1.03E+19	3.49343E+19
		2 pi R/C	1.54E-21	1	2	177	178	Now		
									3.37E+25	
Cell radius	**7.35E-14**	**R=R1+R3**	**7.35E-14**	**7.35E-14**	**8.66E-14**	**3.06E-01**	**3.91E-01**	**5.05E-01**	**6.64E-01**	**3.23E+00**
1.358E-18		R1	7.35E-14	7.35E-14	8.657E-14	2.129E-01	2.506E-01	2.949E-01	3.472E-01	7.859E-01
		R3	7.35E-14	6.54E-33	9.83E-33	9.32E-02	1.40E-01	2.11E-01	3.16E-01	2.44E+00
R universe	5.773E+25	(R1+R3)*exp(60)	8.40E+12	8.40E+12	9.89E+12	3.5E+25	4.46E+25	5.77E+25	7.58E+25	3.68434E+26
				0	3.05E+07	1.25E+08	1.31E+08	1.40E+08		
	938.27	mass mev	938.272	938.272	938.272	938.272	938.272	938.272	938.272	938.272
0.987	0.9897	gamma (g)	0.9897	0.9897	0.9912	1.0000	1.0000	1.0000	1.0000	1.0000
ke orbit	9.781	mev	9.78	9.78	8.31	2.33E-12	1.82E-12	1.41E-12	1.07E-12	2.21E-13
V/C orbit	0.1433		0.1433	0.1433	0.1322	3.34E-12	2.84E-12	2.41E-12	2.05E-12	9.06E-13
velocity	3.00E+08	m/sec	4.30E+07	4.30E+07	3.96E+07	21.10	18.68	16.42	14.33	6.50
Fgravity (nt)		F=M V^2/R/exp(90)	3.44E-38	3.44E-38	2.49E-38	1.99E-63	1.22E-63	7.31E-64	4.24E-64	1.79E-65
G at end	6.6743E-11	G=rV^2/M/exp(90)	6.57E-11	6.64E-11	6.66E-11	6.67E-11	6.67E-11	6.67E-11	6.67E-11	6.67E-11
Fi=MV^2/R/exp(90)		1	3.474E-38	3.438E-38	2.487E-38	1.99E-63	1.22E-63	7.31E-64	4.24E-64	1.79E-65
Pe=Pe+dPE=Pe+Fi dR/2			0	0.00E+00	1.45E+00	9.66E+00	9.66E+00	9.66E+00	9.66E+00	9.66E+00

It is important to note the column labeled NOW. The radius of each cell is 0.50 meters and the velocity related to the reduced kinetic energy is 16.4 m/sec. This combination gives the gravitational constant in terms of the geodesic for the mass of one proton (See Appendix 3). Heading entitled "Time Dilation" in the same appendix gives dt at this radius. Proof that 0.50 and 16.4 m/sec characterize a geodesic for one proton is that they give the gravitation constant G.

Expansion kinetic energy and potential energy

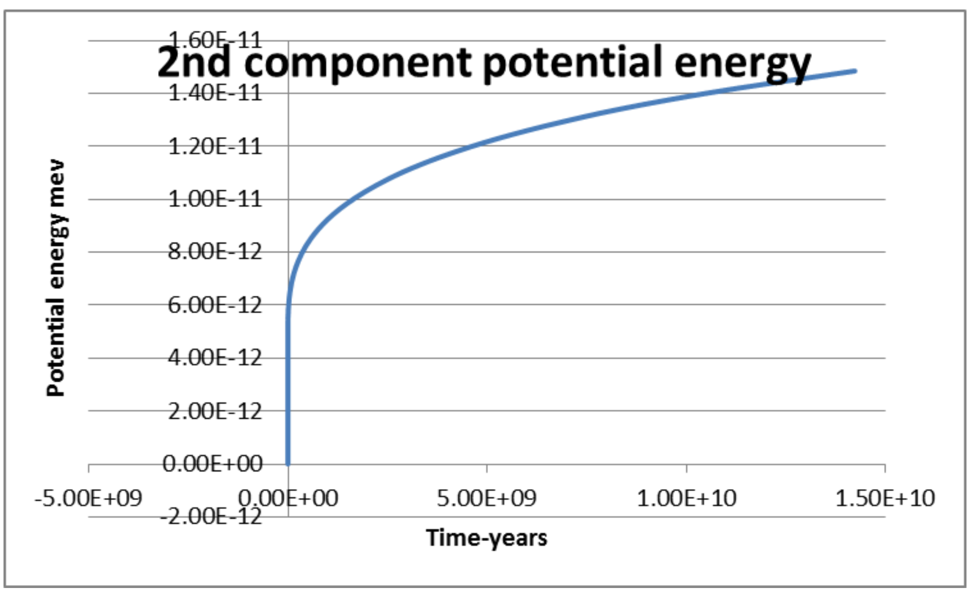
The first line of the derivation (reference 4) for the 8/3 pi G rhoC equation is kinetic energy (ke) = potential energy (pe). Since expansion is well characterized by WMAP (and agrees with the author's calculated expansion), one can simply calculate expansion kinetic energy and expansion potential energy as a function of time and determine if initial ke is in fact turned into final pe. Comparison of expansion kinetic with potential energy in the author's expansion model is included in the table above (the ke line and the pe line are highlighted in gold). The initial kinetic energy is reduced to the current value (labeled NOW) of 1.41e-12 mev. The resisting force is the inertial force Fi=MV^2/R where V is the lateral orbital velocity V/C=0.14 that decreases with increasing R. Final potential energy (integrated over expansion but finalized at the column labeled NOW) is 9.68 mev. Almost all of the initial kinetic energy is converted to potential energy as the following graph shows.



The above plot is based on the assumption of one proton mass per cell.

Why Dark Energy Omega is 0 not 0.72

The formula H^2=4/3 pi G rhoC assumes that the driving force for expansion is kinetic energy (from density and pressure) throughout expansion. WMAP assigns the second component of expansion to a cosmological constant. Using the concordance model (WMAP) equations, the second component is initially only 1e-6 meters and expands to about 2.5e25 meters. This expansion is resisted by gravitational forces and potential energy increases as expansion occurs. When this calculation was carried out, it was found the second component of expansion (cosmological constant) requires very little kinetic energy (on the order of 6.5e-12 out of 9.8 mev). The result is shown below:



The reason for this is that the radius is very low (about 1e-6 meters) in the first part of expansion when the resisting force is high (about 2e-38 NT). Recall that the WMAP conclusion [7] was the 0.72 of the total energy was missing and a search for "dark energy" was launched. In the author's view, it is incorrect to back calculate a critical value of 9.5e-27 from H^2=4/3 pi G rhoC since the second part of expansion (the cosmological constant part of expansion) does not consume kinetic energy. This means that omega dark is negligible. The author is not questioning expansion of the second component and is not questioning that the Hubble constant shows the expansion rate. What is being questioned is that critical density characterizes the expansion.

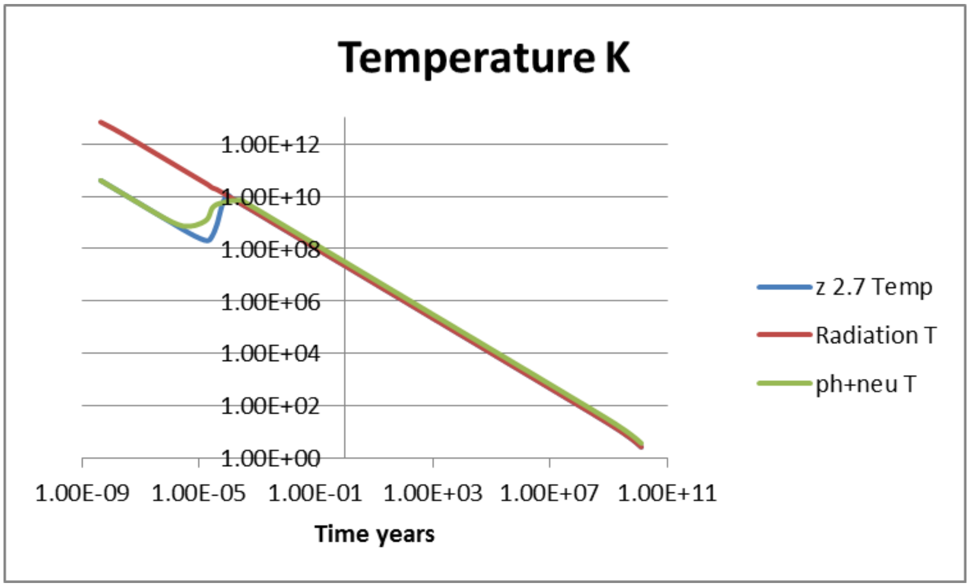
Temperature associated with kinetic energy 9.8 mev

Using the Boltzmann relationship T (K)=ke/(1.5 B), it is possible to assign a temperature to kinetic energy.

KE temperature relationship			Beginning		Current expansion state	
ke=1.5 B T			9.80	mev	1.26E-12	
T=ke/(1.5 B)			7.58E+10	K	0.010	K
Boltzmann B	8.61952E-11	mev/K				
		M=m*exp(0)	2.49E+51		2.18E-08	kg
		R	1.847E+24		1.62E-35	r'
		V (meters/sec)	3.00E+08		3.00E+08	v (meters/sec)
		G	6.68E-11		6.68E-11	

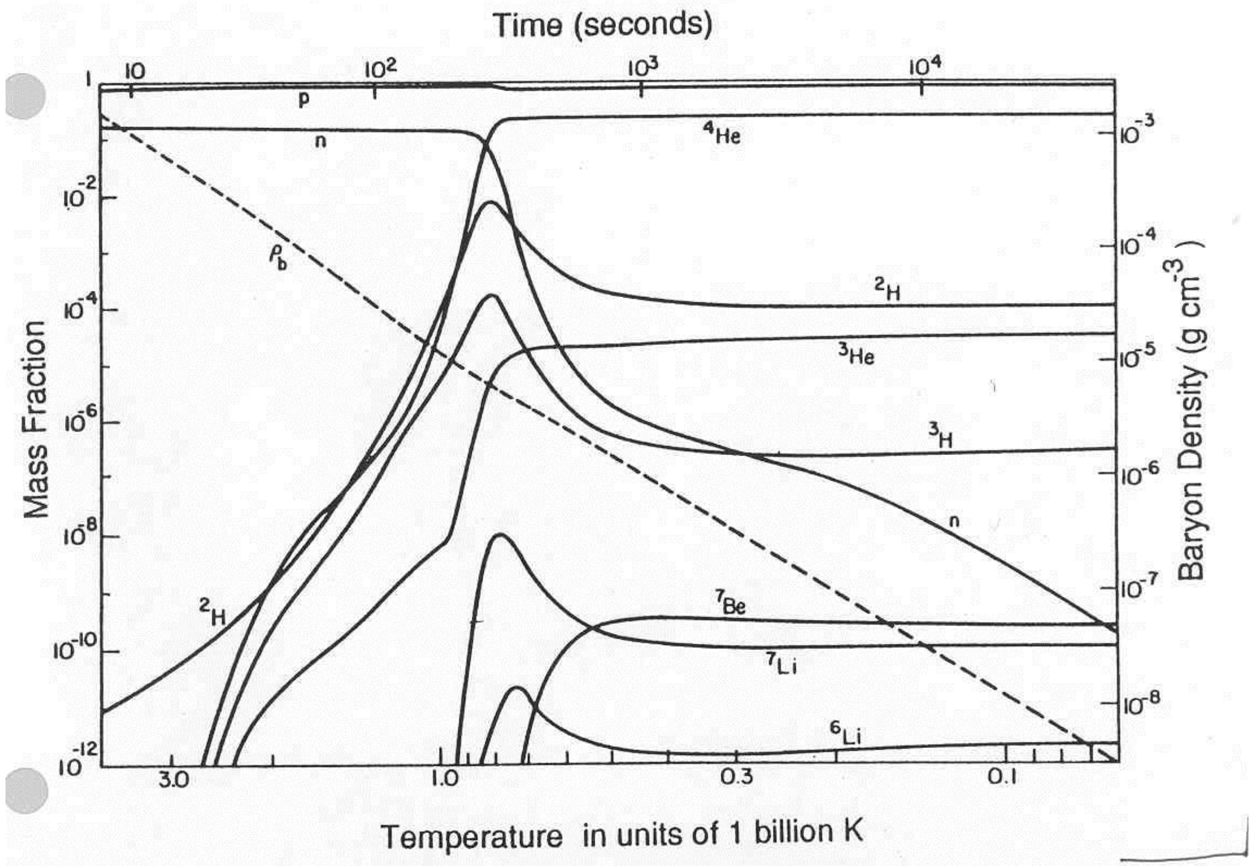
The temperature 7.6e10 K is more reasonable than the 2e13 K temperatures associated with scaling the current radiation temperature 2.725 K all the way back to a low radius (cosmologists use the expansion ratio z to scale temperatures). However, starting with 7.6e10 K and scaling the other way gives the surprising present temperature of 0.01 K. Isn't the present temperature 2.725 K? Recall that production of electromagnetic waves occurs throughout expansion and accumulate. Incremental calculations were carried out for a cell based on the proton producing radiation energy, passing that radiation energy forward in time but reducing the value by expansion. Accounting for radiation, the temperature still follows a downward sloping line. It is well known that Helium4 is produced at high temperatures and is called primordial nucleosynthesis. Most literature gives 23% to 25% as the range of He4 and indicates that it is produced in the first 4 minutes or so. He4 releases 7.07 mev/atom and 0.24*7.07 mev=1.63 mev. This is a significant energy compared to 9.8 mev and adds to temperature. If this is added, the temperature curve moves up to the accepted 2.725*z temperature curve. The scale in the graph below is from the beginning to 13 B years. He4 fusion is shown by the discontinuity at 54.68 log time. (Time in seconds below is natural log time and is converted; seconds=exp(54.68)*1.54e-21=880 sec). The resulting radiation temperature was close to 2.7K at the end of expansion and followed the accepted temperature history.

Note that the blue temperature curve in the graph below is about the same as the red WMAP curve and they both end at 2.72K. This is important because temperature affects the radius at equality and de-coupling. In this simulation, the important equality point on the natural log scale occurs well after the temperature has risen to the accepted temperatures scaled by expansion from 2.72K.



The red temperature line is 2.725 K scaled by expansion ratio z. The author's radius at the "beginning" is lower than most literature cites after inflation and the density and temperature are higher. The blue temperature curve starts at the temperature associated with 9.8 mev (7.56e10 K). However, as neutrons decay to proton, Helium4 starts fusing and releases 7.07 mev*0.23=1.63 mev. Most of this release is heat and adds to the temperature of the blue curve.

The following graph is reproduced from literature showing primordial nucleosynthesis as a function of time and temperature. The temperature of about 1e9 K is the temperature in the graph agrees with the author's expansion temperature calculation of 1e9 K.



http://burro.astr.cwru.edu/Academics/Astr222/Cosmo/Early/nucleosynth_fig.jpg

Literature cites neutron decay and helium4 as temperature decreases and calculates the fraction 0.23 as an event related to “freeze-out”, where the fusion reaction is quenched by lower temperature. Literature does not increase the temperature during energy release, but in this proposal a release of 1.63 mev is a large fraction of 9.8 mev. The author’s blue temperature curve jogs upward by increasing the kinetic energy by 1.63 K and is complete at about 2000 seconds. The adjustment is the correct value because the blue curve temperature is 2.725 K at the present point in expansion.

There is another very important event occurring. The neutron is decaying with a half-life of 886 seconds. The author’s neutron mass model changes to the proton mass model [1] with the release of a neutrino with energy 0.671 mev and an electron (0.551 mev+.1114 ke) with energy 0.662 mev (0.671+0.622=1.293). This energy must also be added to the temperature curve. The green temperature curve shown above is based on neutron decay and also jogs up. The end of this event is at about 6000 seconds and at the end of expansion, its value is 3.79 K This is very important because the photon + neutrino + electron “temperature” is 1.39 times the photon only curve. Temperature is to the power 3 in the equation: Photon density=K*T^3 and this means photon density is 2.68 times higher than 2.725 K based photon density. This will be further reviewed below, but this small change allows the baryon density to be 0.5 while baryon/photon density is the accepted value 6e-10. It is also quite meaningful to the question of what kind of mass WMAP is dealing with. Hot matter (protons and electrons) emit radiation, decays from neutrons to protons and partially fuses to He4. The blue temperature would not jump to the accepted curve if it were cold dark matter.

Important Transitions

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.

Detailed Equality to Decoupling Simulation

When photon density matches and falls below mass density a condition known as equality has occurred. Acoustic oscillations are no longer dampened and wave propagation at velocity C/3^.5 begins. These waves enlarge and are visible in the cosmic background radiation (CMB) as the plasma clears at decoupling. Here are excerpts from concordance expansion calculations (to allow verification, the author put the concordance expansion equations in Appendix 4). Below the white concordance block, the author's R1+R3 results are shown (darker background). Although the expansion curves start at the same radius and end at the same radius, there are small differences. However, the differences do not affect the spot size in radians. Equality and decoupling values are shown in red.

Concordance		3196				1.22E-03	7.10E+02			Saha concordance
9.67E+21	1.25E+22	1.63E+22	2.11E+22	2.73E+22	3.54E+22	4.59E+22	5.95E+22	7.72E+22	1.00E+23	Decoupling r (meters)
5962.64	4599.07	3547.30	2736.02	2110.24	1627.53	1255.19	967.98	746.43	575.54	Expansion ratio
1.63E+04	1.25E+04	9.67E+03	7.46E+03	5.75E+03	4.44E+03	3.42E+03	2.64E+03	2.04E+03	1.57E+03	T concordance (K)
1.22E+20	5.61E+19	2.58E+19	1.18E+19	5.43E+18	2.49E+18	1.14E+18	5.25E+17	2.41E+17	1.11E+17	Photon density n/m^3
3.28E-16	1.50E-16	6.91E-17	3.17E-17	1.45E-17	6.68E-18	3.06E-18	1.41E-18	6.46E-19	2.96E-19	proton mass density
4.58E-16	1.62E-16	5.74E-17	2.03E-17	7.20E-18	2.55E-18	9.02E-19	3.19E-19	1.13E-19	4.00E-20	photon mass density
1.40E+00	1.08E+00	8.31E-01	6.41E-01	4.95E-01	3.82E-01	2.94E-01	2.27E-01	1.75E-01	1.35E-01	photon/mass density
0.00E+00	1.31E+20	3.24E+20	6.10E+20	1.03E+21	1.65E+21	2.57E+21	3.93E+21	5.93E+21	8.88E+21	Wave progression (m)
0.0000	0.0017	0.0032	0.0046	0.0060	0.0074	0.0089	0.0105	0.0122	0.0141	Angle radians
1.51E+20	6.94E+19	3.19E+19	1.46E+19	6.71E+18	3.08E+18	1.41E+18	6.49E+17	2.98E+17	1.37E+17	
Proposal						9.32E-07	5.46E-02	9.30E+04		Saha proposal
8.02E+21	1.04E+22	1.35E+22	1.75E+22	2.27E+22	2.94E+22	3.81E+22	4.94E+22	6.40E+22	8.30E+22	Decoupling r (meters)
7179.21	5537.59	4271.30	3294.51	2541.05	1959.85	1511.52	1165.70	898.94	693.16	Expansion ratio
1.95E+04	1.51E+04	1.16E+04	8.96E+03	6.91E+03	5.33E+03	4.11E+03	3.17E+03	2.45E+03	1.89E+03	T proposal (K)
2.12E+20	9.75E+19	4.47E+19	2.05E+19	9.42E+18	4.32E+18	1.98E+18	9.11E+17	4.18E+17	1.92E+17	Photon density n/m^3
5.75E-16	2.64E-16	1.21E-16	5.56E-17	2.55E-17	1.17E-17	5.38E-18	2.47E-18	1.13E-18	5.20E-19	proton mass density
9.56E-16	**3.38E-16**	**1.20E-16**	**4.24E-17**	**1.50E-17**	**5.32E-18**	**1.88E-18**	**6.66E-19**	**2.36E-19**	**8.35E-20**	photon mass density
1.66E+00	1.28E+00	9.89E-01	7.63E-01	5.88E-01	4.54E-01	3.50E-01	2.70E-01	2.08E-01	1.61E-01	photon/mass density
0.00E+00	0.00E+00	0.00E+00	2.86E+20	7.07E+20	1.33E+21	2.25E+21	3.60E+21	5.60E+21	8.56E+21	Wave progression
0.0000	0.0000	0.0000	0.0026	0.0050	0.0072	0.0094	0.0116	0.0139	0.0164	Angle radians

Photon mass density above is given by the following equation;

Photon mass density=8*PI()/(H*C)^3*(1.5*B*T)^4*1.78e-30				
mev^4 kg		kg/m^3		
(mev^3-m^3	mev			
http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/phodens.html				

B is the Boltzmann constant 8.62e-11 mev/K.

Mass density is:

mass density is = 0.5*1.67e-27*exp(180)/Volume

Equality of photon mass density and mass density occurs at radius 1.35e22 meters for the R1+R3 model. From this point waves progress until the temperature reaches 1000 K. At this point the SAHA equation indicates that decoupling occurs (the SAHA equation is also given in Appendix 4 for verification). The wave has enlarged to 0.0107 radians and matches the WMAP observed CMB spots. The value 0.5*1.67e-27 kg in the above equation for mass density is half the mass of a proton. This is another clue that baryons are more numerous than WMAP analysis indicates but more information is provided below.

Why baryon density is not 0.044

Differences between this proposal and WMAP analysis are summarized below.

WMAP w/o dark	WMAP [7] NOW		Neutron Decay 886 sec	Proposal Equality	Now
5.769E+25	5.77E+25	Radius	2.55E+16	1.35E+22	5.76E+25
	8.04E+77	Volume (m^3)	6.92E+49	1.03E+67	8.00E+77
	3.52E-01	Baryon number density=.5*exp(180)/vol	1.08E+28	7.26E+10	9.31E-01
6.100E-10	6.100E-10	baryons/photon	baryons/(photons+neutrinos		6.02E-10
	5.77E+08	Photon number density	1.02E+37	6.92E+19	1.55E+09
?	0.235	Cold matter fraction		0.5	0.5
		cold matter density in kg/m^3			1.55E-27
0	0.719	Dark Energy		0	0
2.6695E-27	9.50E-27	critical density	1.67e-27*exp(180)/Volume		3.11E-27
?	0.0464	Baryon fraction		0.5	0.5
		baryon matter density in kg/m^3			1.55E-27

Map parameters [7] on the left side of the table above give omega total = 9.5e-27 mev/m^3. Omega dark fraction is 0.718, cold dark mass fraction is 0.235 and baryon mass fraction is 0.046. V^2=8/3 pi G rhoC*R^2 is based on initial kinetic energy becoming potential energy and the author’s calculations show that the second component of expansion (dark energy) is essentially zero, making omega dark energy=0. This means 0.72*9.5e-27/m^3=6.83e-27 must be subtracted from critical density. The new value is 9.5e-27-6.83e-27=2.67e-27 mev/m^3. The three columns on the right give values from the proposal at neutron decay, equality and now. Baryon density is given by 0.5*exp(180)/volume at each of the radius values. The important change in temperature for the now condition gives 1.55e9 (photons+neutrinos+electrons)/m^3. With baryon density 0.931 baryons/m^3, the baryon/photon ratio is 0.931/1.55e9=6e-10. This is in agreement with WMAP and other literature. The argument for a higher baryon fraction is that there are more photons so there can be more baryons. Since the proposed critical density without dark energy is 3.11e-27, the baryon fraction is 0.5. Again, this calculation is very sensitive to temperature since photon density is a function of temperature cubed.

The baryon/photon ratio 6e-10 is not only the accepted WMAP parameter but agrees with primordial nucleosynthesis. Reference 8 is an attempt to correlate meson and baryon masses. In many cases, it appears that there are “mirror particles” and it is the author’s opinion that the cold dark mass fraction of 0.5 may be a neutron like mirror particle of the same mass that interacts only gravitationally. Additional supporting evidence is the anomalous galaxy profiles and dark matter lensing.

Neutron decay and primordial nucleosynthesis

Literature includes many graphs of primordial nucleosynthesis for helium4 and other species. There is consensus that the baryon/photon ratio must be about 6e-10 for the measured values of H2, He3, Be7 and Li7 to have been produced in the first few minutes. This value agrees with WMAP. The decay and helium4 fusion event at 886 seconds corresponds to an expansion radius of 7e15 meters. The absence of dark energy and the green temperature curve may explain why the WMAP baryon fraction is low. If this is the case, the baryon fraction of the universe could be 0.5.

Red shift of spots

The acoustic mass that accumulated at decoupling caused light released from the higher density spot to be red shifted. The red shift measured by WMAP was on the order of 70 micro-degrees for the dominate part of the wave. The author evaluated what the developing cluster above might look like from a temperature standpoint. After decoupling dense pre-clusters red shift escaping radiation. This red shift is measured by WMAP as cool spots on the order of 70 micro-degrees Kelvin. These estimates are for the cluster mass and spot size determined above.

					Temperature of spot based on mass within the spot					
					(This temperature does not include densificiation of the wave. Acoustic waves					
					are compression waves and WMAP was able to discern peaks and anti-peaks.					
spot size				cluster mass	1.290E+47	2.581E+47				
cluster mass				spot	3.8762E+21	3.876E+21				
1+1/(1-(2*0.00000000006675*spot/(cluster mass*300000000^2)))^0.5					1.03E+00	1.05E+00				
(2.925-2.925/(1+(1.02-1)/2000))*1000000					37.51	78.05	micro degrees K			
					WMAP Data:	Maximum peak 70 micro degrees K.				
					References	Bennett				

This indicates that the spot mass is similar to a cluster but the cluster could contain a combination of baryons and cold dark matter.

Conclusion

Using a cosmological model described as the many small surfaces model, expansion and the size of the universe was estimated to be 5.8e25 meters. This agrees with the “concordance model” used by the WMAP project. However, the authors approach allows one to understand what space is, what time is and the origin of the kinetic energy that drives expansion. Space is created by exp(180) cells of 7.35e-14 meters each expanding to universe size space. Equations were developed based on space expanding as time to the (2/3) power and an integration yielding a second expansion term proportional to time to the (5/3) power. There is one protons/cell and all cells are formed by identical laws. Inflation in this model is duplication by exp(180) supporting the cosmological principle. The kinetic energy of expansion and the conversion to potential energy was examined with the cellular approach. The source of constants for gravitation and expansion kinetic energy is the proton mass model [1]. The R1+R3 expansion model kinetic energy is 9.8 mev; enough to expand each initial cell to the present cell radius 0.50 meters against gravitational resisting force in a way that kinetic energy is converted to potential energy. Although there are two components to expansion, the second component develops late when resisting forces are low. The calculated energy (known as dark energy) is negligible and the author believes that critical density estimates from the equation containing H^2=8/3 pi G rhoC must be revised downward to 2.1e-27 kg/m^3. WMAP identifies components of the universe as dark energy (0.718), cold dark matter (0.235) and baryons (0.046). Reanalysis in this document make these values 0, 0.5 and 0.5 respectively. Based on the author's WMAP reanalysis, equality of matter and energy density occurs with 0.5*exp(180) normal protons/m^3. Also, analysis of the spot angle in radians gives the accepted value of 0.0107 as does the spot temperature. The finding that half the total mass is associated with hot baryonic matter was based on adding energy to the temperature curve and was made possible by knowing the initial kinetic energy of expansion. The temperature curves differ from literature but photon only temperature decreases to the measured value 2.725 K with expansion. The important 6e-10 baryon number/photon number value agrees with literature when photon temperature is based on photons+neutrinos+electrons.

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Appendix 1: Relationship between Quantum Scale Gravitational Fundamentals and Universe Size Space

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

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)
M=m*exp(180)

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

At any particular time in expansion

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

Note the factor 1/exp(90). When measurements are made at the large scale as must be done to determine G, the above derivation indicates that we should apply the factor 1/exp(90) to the quantum scale if we expect the same G. This may be surprising. It is generally accepted that the source of the gravitational constant (G) is the Planck scale. The fundamental relationship gives the Compton wavelength (for gravity the Planck length L), L=(\h*G/C^3)^.5 as a function of the reduced Planck or Heisenberg constant (\h pronounced hbar), G and C the speed of light. The Compton wavelength is 1.61e-35 meters and this is associated with the Planck energy 1.2e22 mev. This energy scale is far above the energy of a proton and the space surrounding each proton after inflation is

much above the Compton wavelength. However, gravity is known to be the geometry of space time. It is reasonable that there might be a simple explanation at a small scale that scales through geometry. One should note that this would allow gravity to be defined at a low radius, low energy scale and solve many problems with "quantum gravity".
We are considering a filled sphere and the large volume is proportional to R^3. This is equal to exp(180) cell volumes proportional to r^3. This makes R=r*exp(60) for the relationship between rcell and bigR (universe size space).

Gravitational Constant

The cell model and data from the proton model [1] lead directly to a calculation for the gravitational constant (above under the heading "Source of the Gravitational Constant G"). Physics has struggled with the reconciliation of general relativity and quantum field theory. The main reason for the difficulty is gravity's very low force and very long range effect. The above radius partially defines the geodesic for gravity. The proton is on this radius and its mass and velocity complete the geodesic that defines the gravitational constant.
Note that inertial force m/g*v^2/R*1/exp(90) equals the field force E/R*1/exp(90). This balanced force orbit is caused by firstly, a field of 2.683 mev establishing the radius and secondly a proton falling from a potential energy of 19.34 mev to the radius and developing kinetic energy 9.7 mev. Gravitation is known to be inertial but when a balanced orbit is established the body experiences no net force. When a body of mass M finds the combination of radius R and velocity V where it experiences no acceleration, it is called the geodesic. For the cell with the aid of 1/exp(90), the geodesic is:

V	m/sec	0.144*3e8=4.3e7
M	kg	1.67E-27
R=GM/V^2*exp(90)		7.35e-14 meters

The author believes that the radius 7.35e-14 meters is the fundamental radius of exp(180) cells that define the beginning radius of a large volume associated with the universe. As these cells expand to about 0.5 meters each they define a large radius of about 5.8e25 meters. The author also believes that the value 1.54e-21 sec defines fundamental time. As this value repeats, time increases.

Appendix 2: Proton mass model

ell g228			Mass and Kinetic Energy					Field Energies	
mass	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	17.432	753.291	101.947	641.880				-753.29	
12.432	10.432	0.687							-0.69
13.432	15.432	101.947	13.797	78.685				-101.95	
12.432	10.432	0.687							-0.69
13.432	15.432	101.947	13.797	78.685				-101.95	
12.432	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	0.075		0.000	0.000	-0.671	0.671	v neutrino		
-10.333									
rates here to form proton and electron			129.541	799.251	**938.272013**	**PROTON MASS**			
10.136	10.333	0.62	**0.511**	0.111				5.44E-05	-0.622
0.197	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

For this paper, one important value above is 20.3 of expansion potential energy that forms an orbit with about 10 mev of kinetic energy and 10 mev of potential energy. Another value 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. These are the missing energies that allow baryon fraction to be 0.5. The gravitational field energy 2.683 mev is the basis of the fundamental radius 7.35e-14 meters.

gamma

1

V/C=d/(Ct)

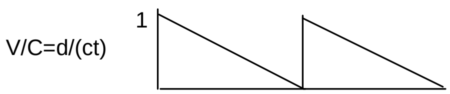
1 1+1

gamma (g)=t/T=tC/CT

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.

Appendix 3: 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. 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.



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

Time Dilation

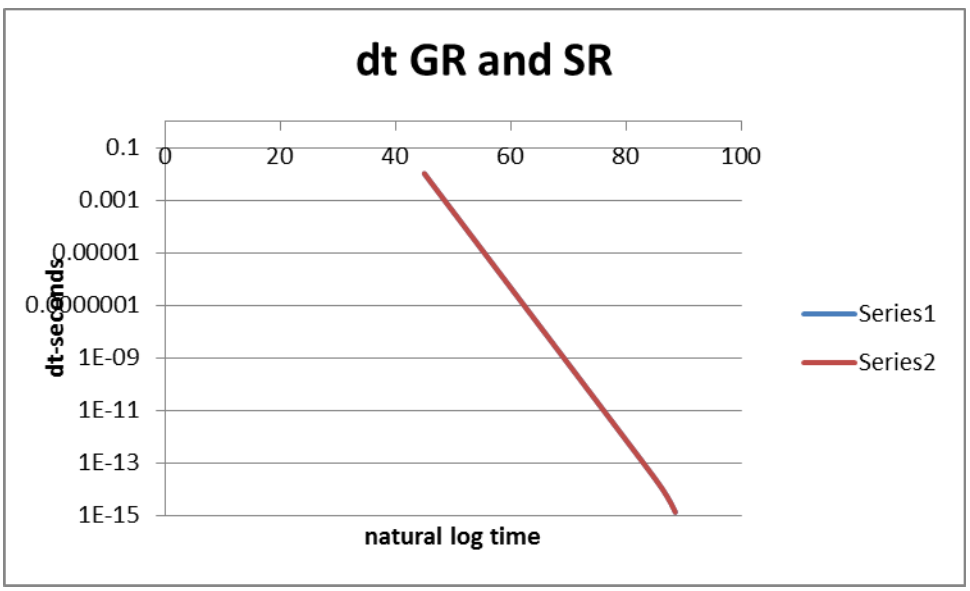
Schwarzschild equations are known to be solutions in general relativity. The following equation is for time dilation. Time dilation is a measure of space time curvature. Here is an example of dt for a cell at its current expansion. Note that the large factor exp(90) has been introduced into the Schwarzschild equation.

	dt=1/(1-2GM/(C^2*R)^.5			
	dt=1/((1-EXP(90)*2*6.67e-11*1.67e-27/(3e8^2*0.563)))^0.5			
		dt=(1-expression above)/2		
	1.000	1.554E-15	sec	

Time dilation dt can also be calculated for cells based on special relativity.

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/M*C^2(1-g^2)		
approximation for (1-g^2)		
dt=(1-g^2)/2		
1.554E-15		
G=rC^2/(M)*2*dt		
r now (meters)		0.505
ke now (mev)		1.41E-12
V now (m/sec)		16.42
low v equation for g		
(ke/938.27)	dt=1-g	1.501E-15
G=rC^2/(M)*2*dt		6.6779E-11
0.5*C^2/1.67e-27/EXP(90)*1.501e-15*2=6.67e-11		

The following plot gives dt for General Relativity and dt for Special Relativity during expansion. Note that they are identical.



In the equations above one can see that a very specific relationship between r and gamma must be maintained to be on the geodesic radius. The ability to predict dt and knowledge of the associated radius allows one to understand what G is. It is simply rC^2/M*2*dt. General and Special Relative is a description of the curvature of space and this simple example gives us curvature. G=Curvature*C^2/M where curvature= r*2*dt. Note that this relationship is only for cells where gamma (g) is near 1, but this is the case throughout expansion.

How does this curvature relate to large space? Curvature is the R in the geodesic equation G=RV^2/M but V has a dt associated with it related to gamma.

Comparing the cell 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 path is a geodesic (R) when the particle does not feel forces (equivalency principle). 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. Note: Big 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				

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 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=0.50 m,V=16.4 m/sec and 1.67e-27 kg).

			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 earth orbit (meters)		6.39E+06		0.505	r is the cell radius		
	R' geodesic (meters)		6.40E+06		0.505	r' is the cell size geodesic (m)		
	Velocity of orbit (m/sec)		7897.71		16.42	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 cell size calculation for G contains a divisor of 1/exp(90) explained above under the heading “Relationship between Quantum Scale Gravitational Fundamentals and Universe Size Space” and references 1 and 6.

For example, standing here on earth our velocity is too low to be in orbit. Our velocity is too low and we are being accelerated by the equation a=G Mearth/Rearth^2. If we could gain about 5000 meters/sec (and keep from hitting things) we could attain an orbit that would match the geodesic. The acceleration we feel on earth is calculated as follows:

	Mass kg (earth	5.98E+24		0.563
	earth R (m)	6378100		
a=gm/r^2	m/sec^2	9.80		

Appendix 4: Calculation Procedures

This calculation procedure should allow one to reproduce Concordance expansion. The equations are incremental and a spreadsheet with time increments as a horizontal axis will allow expansion to be calculated.

Time-sec	0	1*0.0538	2*0538							
Time-sec	0	0.053846	0.1076							
Time-sec	t0	t1	t2							
		Initial								
		Radius								
Concordance Rtotal		8.39E+12	Rtotal=Rmass+Rlambda							
R mass		8.39E+12	Rmass=Rmassp+Vmass*(t2-t2)*3e8							
R lambda		8.69E-07	Rlambda=Rlambdap+Vlambda*(t2-t1)*3e8							
V mass	0.235		Vmass=Rmassp*(0.235*(8/3*PI()*G*9.5e-27)*(4.81e25/Rmassp)^3)^0.5/3e8							
V lambda	0.720		Vlambda=Rlambdap*0.72*2.85e-18/3e8							
Concordance Temp K			T=2.725*(5.79e25/Rtot+1)							
		Notes:								
			Rmassp stand for Rmass in the previous column							
			Rlambdap stands for Rlambda in the previous column							
			This shows a linear time scale. Convert to log scale for convenience.							

The SAHA equation is used to determine when decoupling of radiation occurs. A SAHA value nearing one indicates that the plasma clears.

SAHA Value=4*2^0.5/PI()^0.5*1/3.63e20*1.6e-9*(T/0.511)^(3/2)*EXP(1.36e-5/(8.62e-11*T))