# The cosmic web and dark matter

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## Abstract:

The cosmic web is a filament like structure that connects galaxies. It is imaged by gravitational lensing and is thought to be composed mainly of dark matter since it is very faint in the electromagnetic spectrum. There are computer simulations of the web showing that galaxies are often nodes for multiple branches. https://www.youtube.com/watch?v=ivymdduulFU . Conversely there are volumes in the sky that are relatively devoid of matter. However, cosmologists have long recognized that mass is uniform [18][21] at a scale much larger than the web. Scientists are trying to understand dark matter and dark energy [20]. The unexpected web like structure adds to a list of cosmology unknowns.

The author studied mass accumulation [16] with an expansion model associated with energy values and relationships found in the proton model [Appendix 1]. WMAP [17][19] and later the PLANCK satellites measured cosmic background radiation anisotropy and concluded that there are scale invariant density variations on the order of d'/d=8e-6. The author used this data to predict mass accumulation in three primary levels of structure. It appears that stars, within galaxies within galaxy clusters all result from differential central mass related to measured density variations. Surrounding density is accelerated toward the central mass and densified by radius reduction that obeys a R*v^2=r*V^2 conservation law. Simulations presented agree with several observations including when stars light up, the orbital velocity of stars and Hubble's constant [15]. This paper takes the simulations one step further by studying the shape of the structure.

This paper provides a reasonable explanation for the cosmic web without assuming dark matter [8][12]. Falling mass develops a preferred orientation that changes the shape of the mass, lengthening it into filaments rather than spheres. This is like our atmosphere that forms tornados when there are density differences. In this case, the density difference is the central mass of the star volume. As mass falls toward the central density, it contracts and spins extending the filament outward from the central mass. Simulations of these structures extend between mass accumulating in adjacent areas and appear to be the feature being imaged as the cosmic web.

A realistic looking simulation of a barred spiral galaxy is included.

## Relationships that partition volumes into clusters, galaxies, and stars

At decoupling (decoupling is the condition that clears the plasma), clusters of galaxies and galaxies of stars have specific relationships to extremely long waves. These waves sub-divide an overall sphere (and its associated mass) into smaller and smaller volumes.

Density at decoupling was 2.9e-18 kg/m^3 (from R1+R3 expansion model [8][13] [Appendix 3] but consistent with WMAP).
Ru universe at decoupling=5.9e22 meters (from expansion model but consistent with WMAP)
Wave-length data from equality to decoupling (WMAP)= 2.35e21 meters
N clusters= (R decoupling/2.35e21)^3=1.58e4
Observation data (Wiki): Ngalaxies =2e12=Nclusters*Ngalaxies/cluster=1.58e4*1.27e8
Mu=exp(180)*1.67e-27= 2.48e51 Kg (Appendix 1)
Mass/galaxy= 2.48e51/2e12=1.24e39 Kg
Observed average mass of stars (Wiki)=5.8e29 Kg
Potential number of stars=2.48e51/5.8e29=4.29e21

The information above can be summarized as follows.  The number (N) of structures in the next smaller sphere (r) is related to radius R and r for the two spheres; i.e. N=(R/r)^3.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.95E+22 | R decoupling (M) | | 2.35E+21 | Previous sphere | | 4.67E+18 | Previous sphere |
| 1.58E+04 | N clusters | 2.01E+12 | 1.27E+08 | N galaxies in cluster | 4.29E+21 | 2.13E+09 | N stars in galaxy |
| 2.35E+21 | Jeans at decoupling (M) | | 4.68E+18 | Galaxy sphere (Jeans) | | 3.63E+15 | Star sphere (Jeans?) |
| 1.57E+47 | Avg mass of cluster (Kg) | | 1.24E+39 | Avg mass of galaxy (Kg) | | 5.80E+29 | Avg mass of star (Kg) |

We observe clusters of galaxies and galaxies, all made of stars.

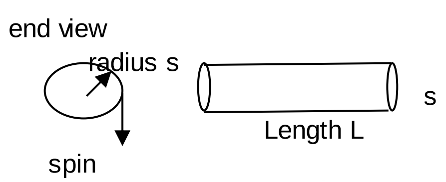
## Density variations and central mass

Each line of the table below represents a radius across one of the spheres defined above.  Each sphere has a slight density variation (d’/d=8e-6) from center to edge.  The peak density varies as a cosign wave that starts as a maximum on the left.  For example, WMAP [11] measured a maximum delta temperature of 74 micro-degrees at the peak after the wave reached a length of 2.35e21 meters after growing from zero at equality (equality of mass and photon density where waves can propagate).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster Jeans | 2.35E+20 | 4.7E+20 | 7.05E+20 | 9.4E+20 | 1.175E+21 | 1.41E+21 | 1.645E+21 | 1.88E+21 | 2.115E+21 | 2.35E+21 | 1.37E+21 |
| density | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | |
| den/dens | 1.0000792 | 1.00007799 | 1.00007442 | 1.00006859 | 1.00006067 | 1.00005091 | 1.0000396 | 1.00002709 | 1.00001375 | 1 | |
| mass in shell | 1.57E+44 | 1.10E+45 | 2.99E+45 | 5.81E+45 | 9.58E+45 | 1.43E+46 | 2.00E+46 | 2.66E+46 | 3.41E+46 | 4.26E+46 | 1.571E+47 |
| central mass | 1.25E+43 | 1.23E+43 | 1.17E+43 | 1.08E+43 | 9.57E+42 | 8.03E+42 | 6.25E+42 | 4.27E+42 | 2.17E+42 | 0.00E+00 | |
| | 1.249E+43 | | | | | | | | | | |
| | | | | | | | | | | 4.68E+17 | |
| Galaxy | 4.6769E+17 | 9.3538E+17 | 1.4031E+18 | 1.8708E+18 | 2.3385E+18 | 2.8062E+18 | 3.2738E+18 | 3.7415E+18 | 4.2092E+18 | 4.67692E+18 | 2.72E+18 |
| density | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | |
| den/dens | 1.0000792 | 1.00007799 | 1.00007442 | 1.00006859 | 1.00006067 | 1.00005091 | 1.0000396 | 1.00002709 | 1.00001375 | 1 | |
| density | 2.8902E-18 | 2.8902E-18 | 2.8902E-18 | 2.8902E-18 | 2.8902E-18 | 2.8901E-18 | 2.8901E-18 | 2.8901E-18 | 2.89E-18 | 2.89E-18 | |
| mass in shell | 1.24E+36 | 8.67E+36 | 2.35E+37 | 4.58E+37 | 7.55E+37 | 1.13E+38 | 1.57E+38 | 2.09E+38 | 2.69E+38 | 3.36E+38 | 1.238E+39 |
| central mass | 9.85E+34 | 9.70E+34 | 9.25E+34 | 8.53E+34 | 7.54E+34 | 6.33E+34 | 4.92E+34 | 3.37E+34 | 1.71E+34 | 0.00E+00 | |
| | 9.8456E+34 | | | | | | | | | 4.19E+14 | |
| | | | | | | | | | | 3.6E+14 | |
| Stars | 3.63E+14 | 7.3E+14 | 1.1E+15 | 1.5E+15 | 1.8E+15 | 2.2E+15 | 2.5E+15 | 2.9E+15 | 3.3E+15 | 3.6E+15 | 3.63E+15 |
| density | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | |
| den/dens | 1.0000792 | 1.00007799 | 1.00007442 | 1.00006859 | 1.00006067 | 1.00005091 | 1.0000396 | 1.00002709 | 1.00001375 | 1 | |
| density | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | 2.89E-18 | |
| mass in shell | 5.79E+26 | 4.05E+27 | 1.10E+28 | 2.14E+28 | 3.53E+28 | 5.27E+28 | 7.35E+28 | 9.79E+28 | 1.26E+29 | 1.57E+29 | 5.791E+29 |
| central mass | 4.59E+25 | 4.52E+25 | 4.31E+25 | 3.97E+25 | 3.51E+25 | 2.95E+25 | 2.29E+25 | 1.57E+25 | 7.96E+24 | 0.00E+00 | |

## Cosmic web mass accumulation

The analysis above partitions the overall volume and mass into sub-volumes (green values above) based on the density and radius of the universe at decoupling. Some galaxies are spherical or elliptical, but the most prevalent galaxies are spiral galaxies and barred spiral galaxies like the Milky way. Spiral galaxies are flattened into disks (about 5% as thick as they are wide). In the following analysis, the disk-like shape is related to accumulation of gas filaments that extend outward from the galaxy center. These spinning filamentary web-like structures form due to gravity and contract into small orbits. As they attract additional mass their length and radius increase. Falling mass that does not follow this scheme collides and is redirected around the radius.




| | |
|---|---|
| vol=4pi s^2*L | |
| L/s=.05 | |
| L=s*.05 | |
| s=(vol/(4 pi/.05)^.33 | |

| central mass | | | V=A*L | | s=(vol/(4 pi/.05)^.33 | | | |
|---|---|---|---|---|---|---|---|---|
| mass | density | Structure | volume (m^3) | Filament area | (m) | r if sphere | L=s/.05 | s/L |
| 5.79E+29 | 2.89E-18 | Stars | 2.00E+47 | | 2.10E+15 | 3.63E+15 | | 1.00 |
| 5.79E+29 | 2.89E-18 | Stars | 2.00E+47 | 1.08E+31 | 9.27E+14 | 3.63E+15 | 1.85E+16 | 0.05 |
| 1.24E+39 | | Galaxies | 3.26E+50 | | 1.09E+16 | 4.27E+16 | 2.18E+17 | 0.05 |
| 1.57E+47 | | Clusters | 8.66E+57 | | 3.25E+18 | 1.27E+19 | 6.51E+19 | 0.05 |

At decoupling, the density is 2.9e-18 Kg/m^3. The analysis uses a filament radius (s) that is 5% of its length. The table above gives the partitioned volume for each of the structures based on their mass. For example, the volume associated with a 5.8e29 Kg potential star at this density is

2e47 m^3.  The filament radius and length are shown for each structure with s= 0.05*L.  For comparison, the column labelled “r if sphere” is for accumulation into spheres.

## Accumulated mass as a function of time from decoupling

Accumulation starts with a few protons forming a central mass for gravitational accumulation. Acceleration toward the mass is given by the equation below:

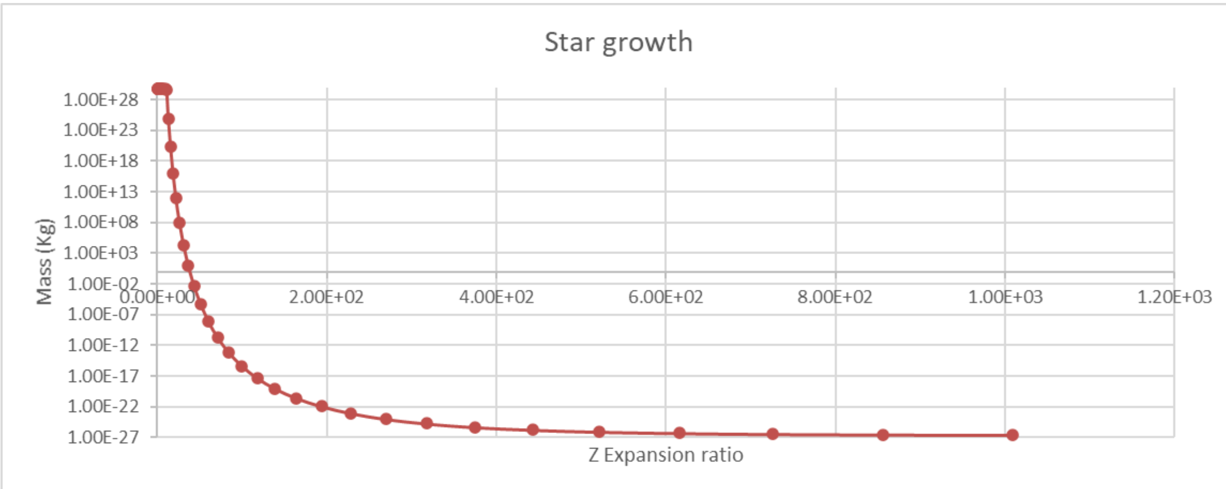
| **Touch down equation** | |
|---|---|
| | |
| D=at^2/2=1/2*GM/D^2*(2D/at)^2=GM/(at)^2 | |
| at^2=2GM/(at)^2 | |
| a^3*t^4=2GM | |
| a=(2GM/t^4)^.333 | |

D is the distance mass can travel under acceleration a.  Delta time (t) is incrementally calculated based on time increments in an expansion model.  Velocity (at) and radius (D=2Gm/(at)^2) are substituted into the equation for acceleration.  The equation can be simplified to a= (2GM/t^4)^(1/3).  This is the acceleration that mass experiences as it gravitates toward the central mass M.

The equation is placed in an incremental expansion model.  A filament of radius (s)= 0.5*acceleration*(delta time)^2 forms around the central mass.  Columns of calculations below are for mass accumulation at various times to the present (cells were hidden in this several hundred step model).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mass sum (Kg) | | | 1.67E-27 | 2.43E-27 | 7.60E+24 | 4.24E+29 | 5.80E+29 | 5.80E+29 | |
| acceleration=(2*CM*6.675e-11/(time-time')^4)^0.333 (m/sec | | | 1.60E-29 | 1.30E-29 | 3.64E-16 | 1.00E-14 | 7.98E-15 | | |
| | | | | | | | | | |
| | | | | | | | | 5.80E+29 | |
| Distance (s) enclosed by a=0.5*a*(time-time')^2 (m) | | | 5.90E-05 | 7.88E-05 | 8.35E+14 | 3.76E+16 | 4.92E+16 | 4.92E+16 | |
| Radius that would enclose volume | | | 2.310E-04 | 3.085E-04 | 3.269E+15 | 3.628E+15 | 3.628E+15 | | |
| L filament length | L=s/.05 | | 1.18E-03 | 1.58E-03 | 1.67E+16 | 7.53E+17 | 9.85E+17 | 9.85E+17 | |
| Delta mass. M (Kg) | vol density=delta Kg | | 7.57E-28 | 3.57E-28 | 4.24E+29 | 1.56E+29 | 0.00E+00 | 0.00E+00 | |
| Ri=7.045e-14*10.15/ke initial*(M/1.67E-27)*1/EXP(90) | | | 2.27E-61 | 9.12E-47 | 2.85E+05 | 1.59E+10 | 2.18E+10 | 2.16E+10 | 0.05 |
| Rstar ref=(3/(4*PI())*mass/1440)^(1/3) | | | 6.52E-11 | 7.38E-11 | 1.08E+07 | 4.13E+08 | 4.58E+08 | 4.58E+08 | |
| Rf=7.045e-14*10.15/ke initial*(M/1.67E-27)*1/EXP(90)*fr | | | 3.41E-67 | 1.37E-52 | 4.28E-01 | 2.39E+04 | 3.27E+04 | 3.25E+04 | 1.50E-06 |
| Volume (meters^3) | | | 5.16E-11 | 1.23E-10 | 1.46E+47 | 2.00E+47 | 2.00E+47 | 2.00E+47 | |
| Vi=(2*ke initial/1.67E-27*1.6e-13)^0.5 (m/sec) | | | 9464.24 | 9459.65 | 9464.24 | 9464.24 | 9464.24 | 9464.24 | |
| Vf=((Vi^2*Ri)/Rf)^.5 (m/sec) | | 5.79E+29 | 7.73E+06 | 7.72E+06 | 7.73E+06 | 7.73E+06 | 7.73E+06 | 7.73E+06 | |
| density | | | 2.90E-18 | 2.90E-18 | 7.78E-19 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.12E-04 |
| density/fall ratio^3 | fallratio=.062 | 1.46E-17 | 1.46E-17 | 2.90E-18 | 2.90E-18 | 7.78E-19 | 0.00E+00 | 0.00E+00 | 5.93E-01 |

After each time increment, delta mass=4pi*s^2*L*density adds (the arrow above) to the accumulating mass (the top line above).  Mass accumulation is proportional to the mass sum (exponential) but there is a limited amount of mass in the partitioned volume for each star (2e47 m^2).   The columns above labelled (7.6e24, 4.24e29 and 5.8e29 Kg) show the mass approaching and reaching the mass of an average star at (5.8e29 Kg) as time progresses to the right of the table.  At this point the density is depleted leading to conditions at the present time in the rightmost column.  The filament radius is 4.93e16 meters after the mass reaches 5.8e29 Kg the filament is extremely long (L=1e18 meters).  It can reach between and into adjacent star volumes that are on average about 7e15 meters away from one another. The red line below is for mass accumulation into a filament. The mass is too low to initiate fusion until it reaches about z=8 on the left side of the chart.




The sun has an overall density of 1440 kg/m^3. The density in the 2e47 m^3 volume partitioned for each star was 3e-18 kg/m^3. The line of calculations in the table above labelled Ri and Rf explain where some of the densification takes place. The initial radius (Ri) of an orbit with 5.8e29 Kg of mass in a filament will orbit at 2e10 meters. The velocity Vi (initial velocity) in the table is for the kinetic energy in the gas that accumulated. The volume at condition Ri is Vol=4*pi*2e10^2*1e18= 5.8e39 m^3. The mass/volume=density= 5.8e29/5.8e39=1e-10 kg/m^3. This represents mass that has accumulated into long gas clouds extending outward from the center of the galaxy. They would be difficult to observe since they are not dense enough to form stars. Density at this stage has increased from 2e-18 to 1e-10 Kg/m^3 but further densification occurs as the mass falls. The line in the table above that represents this condition is labelled Rf (for final radius). Orbital radius Rf=r*10.15/ke*(Mstar/1.67e-27)*1/exp(90)*1.5e-6=3.25e4 meters. This radius reduction increases the filament density. The low value 3.25e4 meters is still a long filament but will consolidate into a spherical star as described below. The density is now about 0.2 kg/m^3 and represents the density of the upper layer of the potential star. A spherical star with this mass would be 4.5e8 meters in radius, for comparison.

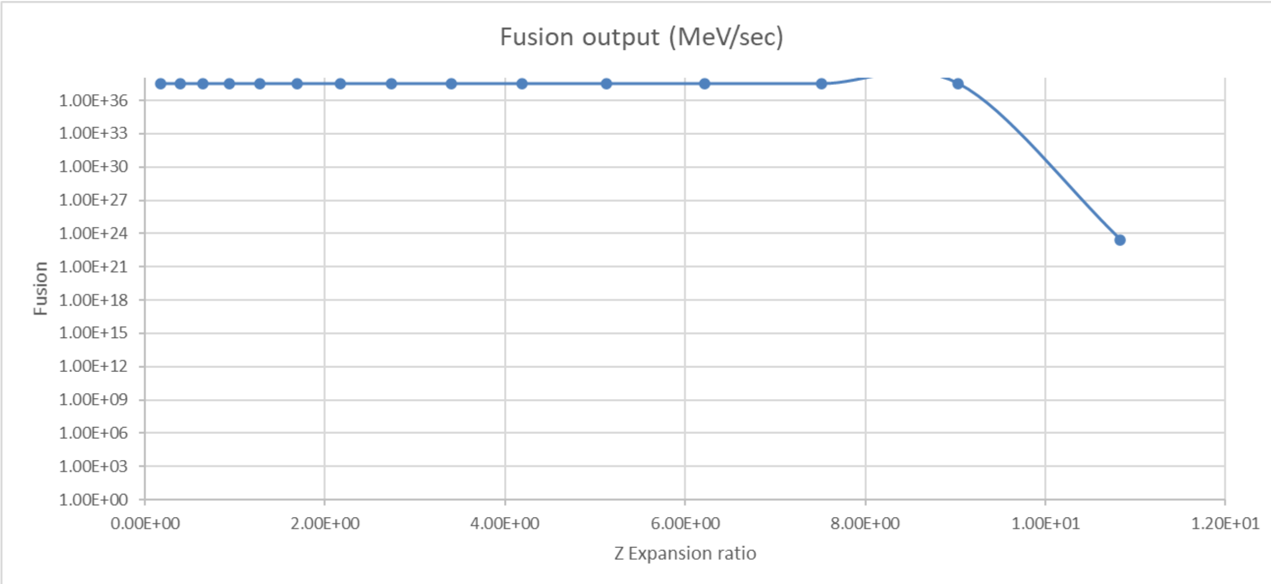
## Star development along filaments

Before the star can light up as indicated above, it must consolidate along the filament. Flow of mass toward to developing star is another calculation carried out with the "touch down equation". The flow must start earlier than Z=8 since it takes time for the parts of the filament to form spherical stars. The calculations are shown below:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Z Expansion ratio | 30.8 | 26.0 | 21.9 | 18.4 | 15.4 | 13.0 | 10.8 |
| Mnode | 1.09E+07 | 8.45E+10 | 1.07E+15 | 2.23E+19 | 7.60E+23 | 4.24E+28 | 5.80E+28 |
| acceleration=(2*M*6.675e-11/(time-time')^4)^0.333 (m/ | 1.53E-21 | 2.18E-20 | 3.66E-19 | 7.24E-18 | 1.69E-16 | 4.64E-15 | 3.70E-15 |
| | | | | | | | |
| Distance= 0.5*a*(t-t)^2 | 2.44E+08 | 5.69E+09 | 1.56E+11 | 5.07E+12 | 1.94E+14 | 8.74E+15 | 1.14E+16 |
| M to node (mass=distance*filament area*dens) Kg | 1.16E-26 | 1.62E-17 | 7.17E-08 | 1.01E+03 | 4.46E+13 | 6.28E+24 | 1.53E+25 |

A layer by layer analysis of the density and temperatures down to the center of the star is required to understand further densification. When the mass of the star reaches 5.8e29 the density at the core is on the order of 1e5 kg/m^3. The calculations below determine if there is potential for fusion (in this analysis fusion kinetics are probabilistic [3] [appendix 4]. The rise in potential fusion power (MeV/sec) occurs at about Z=8. These are extrapolations from the Sun for stars with less mass. The sun simulation is shown below. Density and temperature coupled with mass accumulation determine the propensity to light up with fusion. The layers are labelled layer 1 to layer 10 (layer 10 is the core where fusion occurs). The shaded calculations are for fusion.

| | | | | | | |
|---|---|---|---|---|---|---|
| 2.00E+30 | | | | | | |
| 1.08E+00 | m/m | | | | | |
| 2.15E+30 | | | | | | |
| 4.00E-02 | rho0 | | | | | |
| 7.13E+05 | | | | | | |
| 6.90E+08 | radius of "sta | Top layer | | 2.76E+08 | h | 7th Layer |
| 1 | | | | 0.16 | A/A | |
| 2.81E+02 | ghigh | kinetic Energy | | 1.76E+03 | ghigh | kinetic Energ |
| 3.62E+03 | T (red=fl) | 4.67E-07 | | 1.08E+07 | T | 1.39E-03 |
| 1.65E+25 | mass | | | 2.18E+29 | mass | |
| 7.78E+08 | P | | | 5.47E+14 | P | |
| 4.36E+01 | rhonew | | | 1.03E+04 | rhonew | |
| 6.21E+08 | h | 2nd Layer | | 2.07E+08 | h | 8th Layer |
| 0.81 | A/A | | | 0.09 | A/A | |
| 3.47E+02 | ghigh | kinetic Energy | | 2.35E+03 | ghigh | |
| 1.80E+06 | T | 2.32E-04 | | 1.26E+07 | T | 1.62E-03 |
| 1.46E+28 | mass | | | 3.84E+29 | mass | |
| 1.05E+12 | P | | | 2.22E+15 | P | |
| 1.18E+02 | rhonew | | | 3.59E+04 | rhonew | |
| 5.52E+08 | h | 3rd Layer | | 1.38E+08 | h | 9th Layer |
| 0.64 | A/A | | | 0.04 | A/A | |
| 4.40E+02 | ghigh | kinetic Energy | | 3.52E+03 | ghigh | kinetic Energ |
| 3.59E+06 | T | 4.63E-04 | | 1.44E+07 | T | 1.85E-03 |
| 3.13E+28 | mass | | | 5.93E+29 | mass | |
| 4.64E+12 | P | | | | | |
| 2.62E+02 | rhonew | | | | | |
| 4.83E+08 | h | 4th Layer | | | | |
| 0.49 | A/A | | | 4.24E+03 | | |
| 5.74E+02 | ghigh | kinetic Energy | | 1.09E+16 | P | |
| 5.39E+06 | T | 6.95E-04 | | 1.55E+05 | rhonew | |
| 5.31E+28 | mass | | | 6.90E+07 | h | 10th Layer |
| 1.50E+13 | P | | | 0.01 | A/A | |
| 5.67E+02 | rhonew | | | 9.85E+03 | ghigh | kinetic Energ |
| 4.14E+08 | h | 5th Layer | | 1.61E+07 | T | 2.08E-03 |
| 0.36 | A/A | | | 6.39E+29 | mass | |
| 7.82E+02 | ghigh | kinetic Energy | | 1.16E+17 | P | |
| 7.18E+06 | T | 9.26E-04 | | 1.46E+06 | rhonew | 1 |
| 8.43E+28 | mass | | | 1.61E+07 | temp core | |
| 4.57E+13 | P | | | 1.46E+06 | Kg/m^3 | |
| 1.29E+03 | rhonew | | | 2.00E+30 | | |
| 3.45E+08 | h | 6th Layer | | 1.46E+06 | density Kg/m^3 | |
| 0.25 | A/A | | | 1.61E+07 | Temp (K) | 2.08E-03 |
| 1.13E+03 | ghigh | kinetic Energy | | 2.77E-06 | p1 | |
| 8.97E+06 | T | 1.16E-03 | | 1.48E-03 | p2 | |
| 1.33E+29 | mass | | | 5.804E-09 | p3 | |
| 1.46E+14 | P | | | 2.38E-17 | P | |
| 3.31E+03 | rhonew | | | 8.8 | B years | |
| | | | | 1.20E+57 | N | |
| | | | | 0.082 | fract burn | |
| | | | | 2.34E+39 | N/sec | |
| | | | | 1.56E+40 | Fusion MeV/sec | |



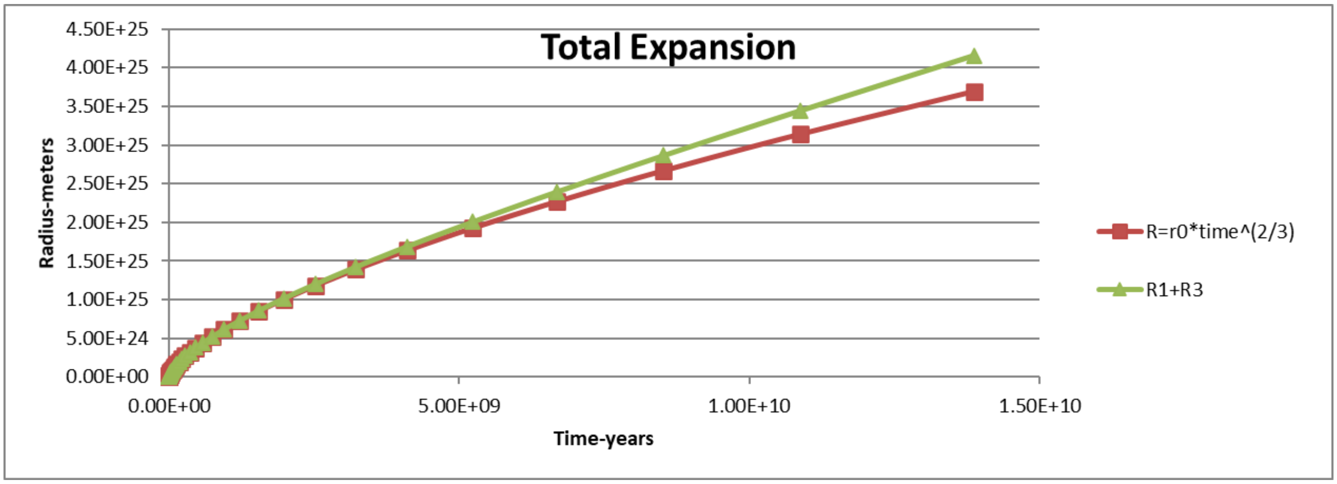

## Hubble measurements

There are other ways to determine if calculations for filament accumulation agree with measurements. WMAP reported a Hubble [11] value of 2.2e-18/sec. But other measurements using supernovae indicate that the universe is experiencing late stage expansion. This was unexpected and a Hubble constant of 2.39e-18/sec is reported [15][20].

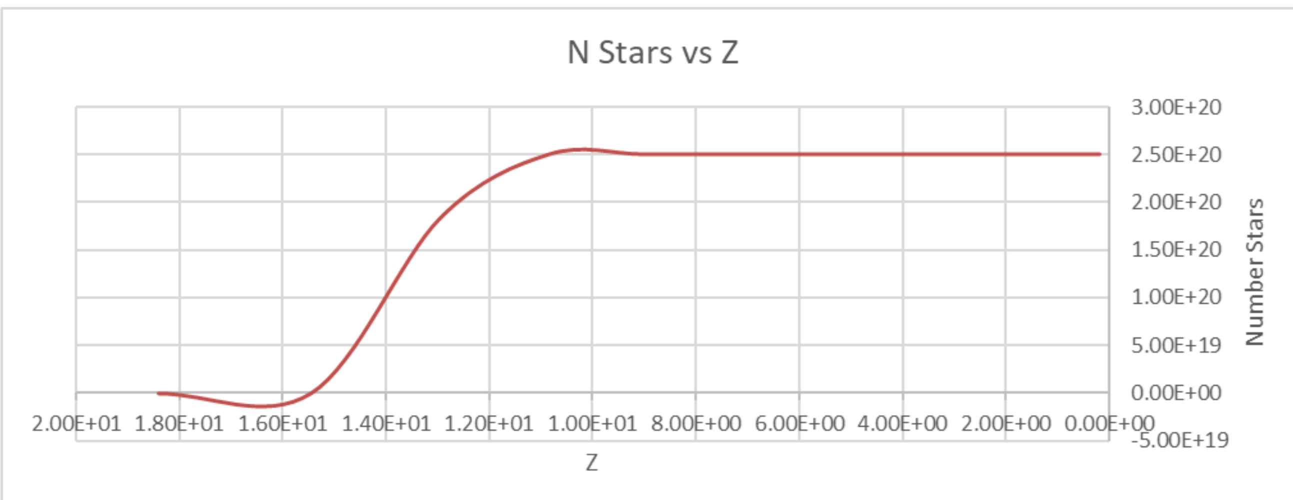
The author's expansion model R1+R3 can be used to calculate the Hubble constant. Mass accumulation creates gravitationally bound objects. The space they take is fixed and the universe around them expands. The distance between the expanding universe radius (Ru) and the combined fixed radius of the stars (Rs) increases with time. The Hubble constant = (Ru-Rstars)/(delta t*Ru), where delta t is an increment in the expansion model. This is a function of the number of stars. The potential number of stars = 1.67e-27*exp(180)/5.8e29= 4.3e21 but matching conditions below indicate that only 7% of the virgin density has been converted to stars.

## Dark energy substitute

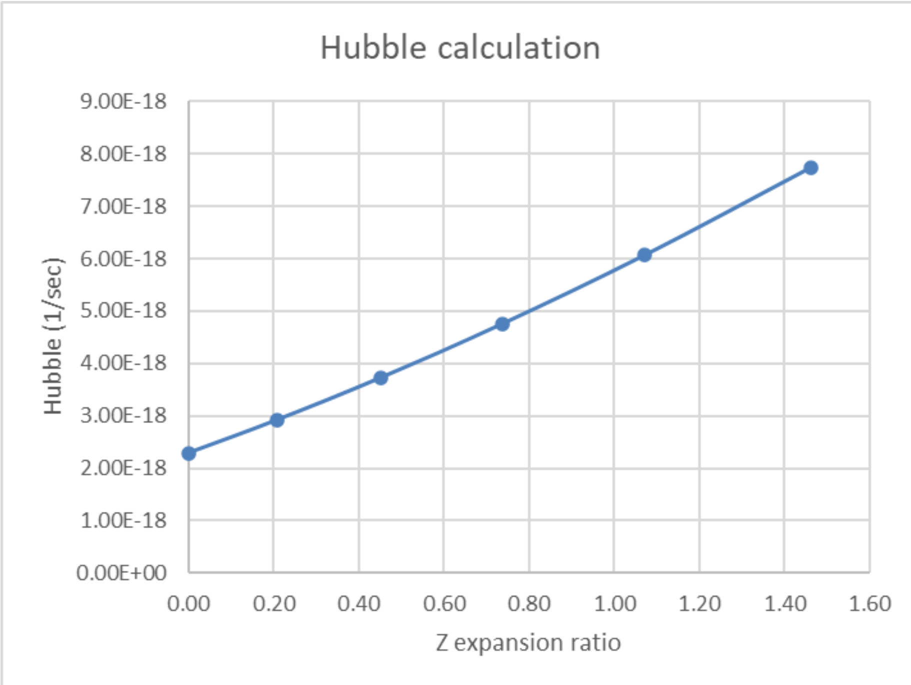
Toward the end of expansion observations indicate that expansion is increasing at a constant rate (some have measured acceleration). This is controversial but this is a way of determining if calculations agree with observations. This was the subject of reference 8. Expansion energy and forces becomes extremely low late in expansion. When stars ignite with fusion they add a significant amount of energy. Calculations show that this keeps the expansion curve from following the falling expansion curve proportional to time^(2/3). I believe photon energy represents the second expansion component. It makes the curve more linear and replaces the concept of dark energy. The number of stars producing this energy rate (from the model) agrees with the cosmic background radiation temperature, 2.73K.



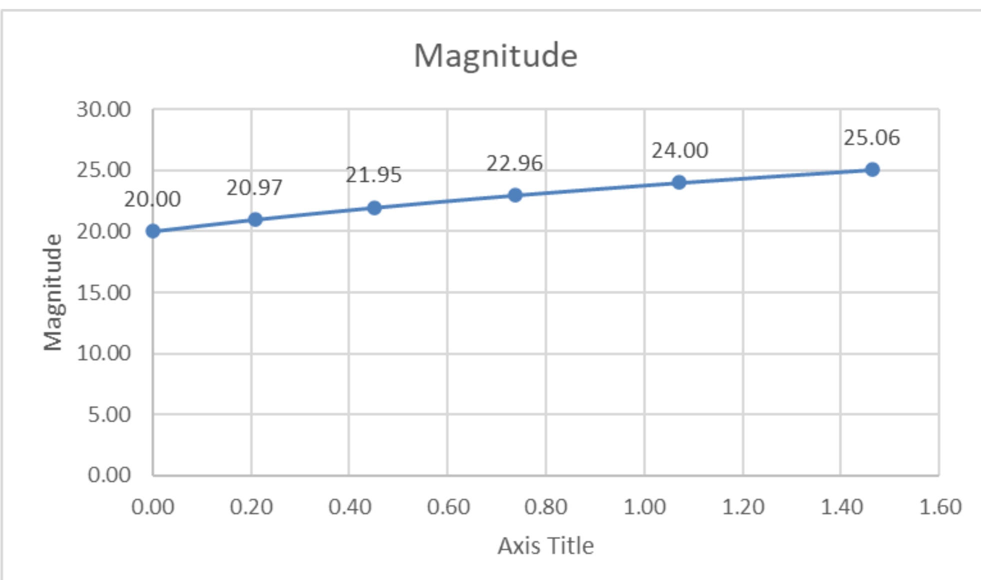

The model indicates that 7% of the available mass has been converted to stars at the present time when the calculated and measured cosmic background radiation temperature is 2.73 K. This also matches Hubble measurements.




Here is the calculation of Hubble's constant for matching conditions:

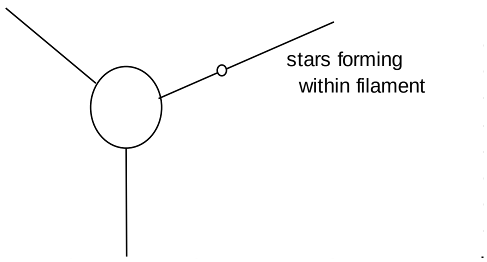



The Hubble value changes because expansion was faster in the distant past and Ru was lower. When the sun was formed 4 billion years ago, Z was about 0.35. Hubble constant (H) has dropped to 2.2e-18/sec at the present time. Measurements earlier than about Z=1 are difficult. Magnitude (dimness) is a function of distance^(1/4). Literature indicates measurements [15][20] along the line below (magnitude 25 at approximately Z=1). The magnitude line below is for the authors expansion model for matching conditions; temperature, Hubble constant and reported magnitude.

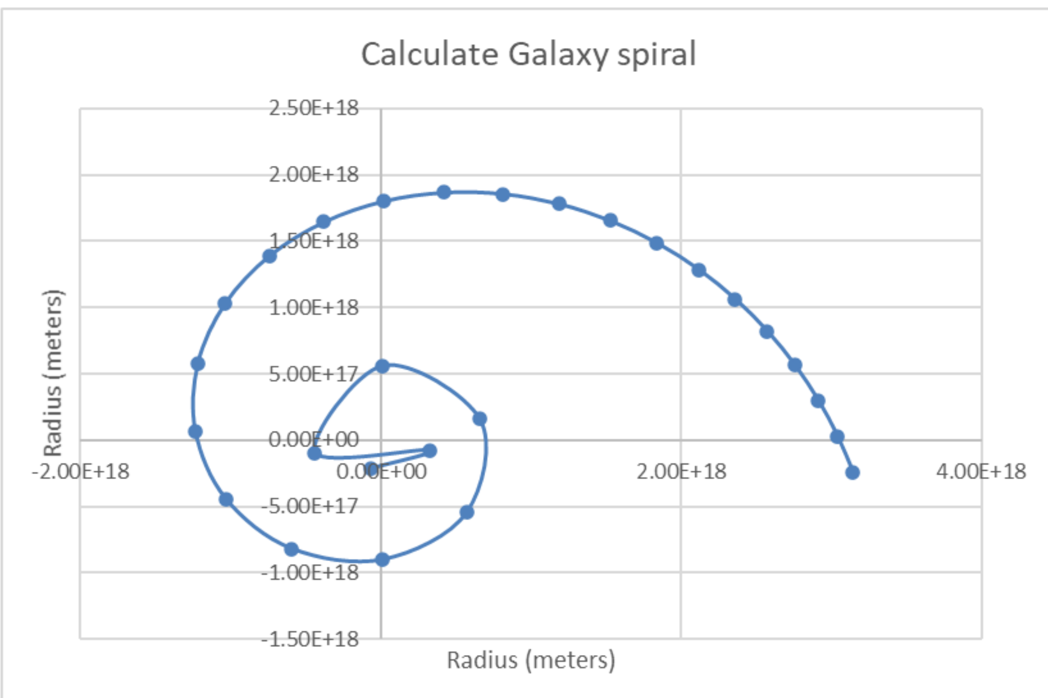


## Mass accumulation in galaxies from star filaments

For galaxies, the accumulation process is dependent on mass falling toward a central mass [16][Appendix 5]. The potential stars are located along filaments trailing out from the galaxy. The gas the will become stars is becoming more spherical as time passes and can be visualized as follows:

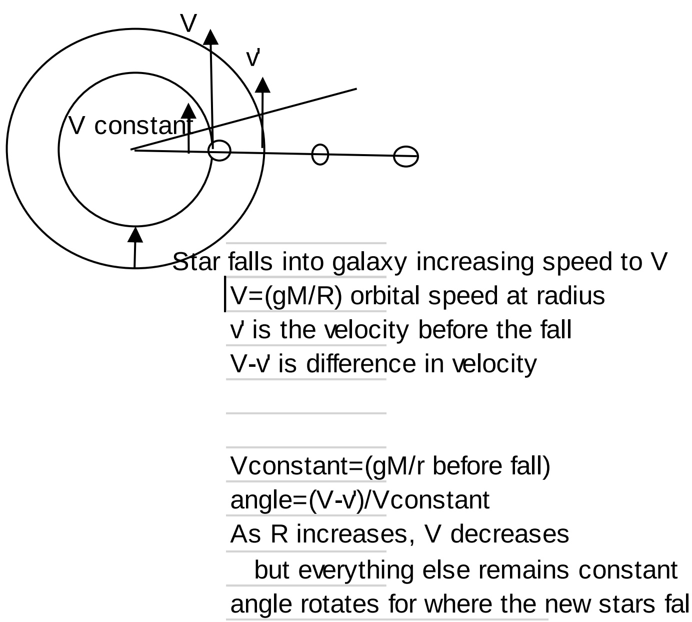


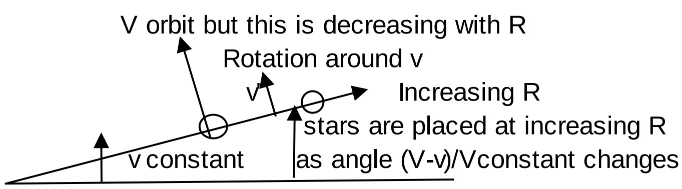

The process that forms a disk like spiral galaxy is described below with accompanying calculations.




As the stars in the filament fall toward the galaxy, their distance from the central mass decreases and their velocity increases. They will fall to a position related to their kinetic and potential energy. Before the fall, their velocity is v. After the fall they will establish an orbital velocity V=(GM/R)^0.5 (this velocity is around the central mass, not the velocity of the filament radius). The change in velocity (V-v) will be different compared to stars that fell into the galaxy in the previous time increment and radius. But the entire galaxy of stars is rotating and angular velocity times radius establishes a reference velocity, Vconstant. The ratio (V-v)/Vconstant is an angle. As R increases, V=(GM/R)^0.5 changes and as V changes, the angle changes. The related changes in radius R and angle describe a spiral. Filaments containing developing stars fall toward the central mass but are deflected into the shape we see. If Vconstant is established early, it will be lower and the spiral will appear more tightly wrapped.

Here are the equations:



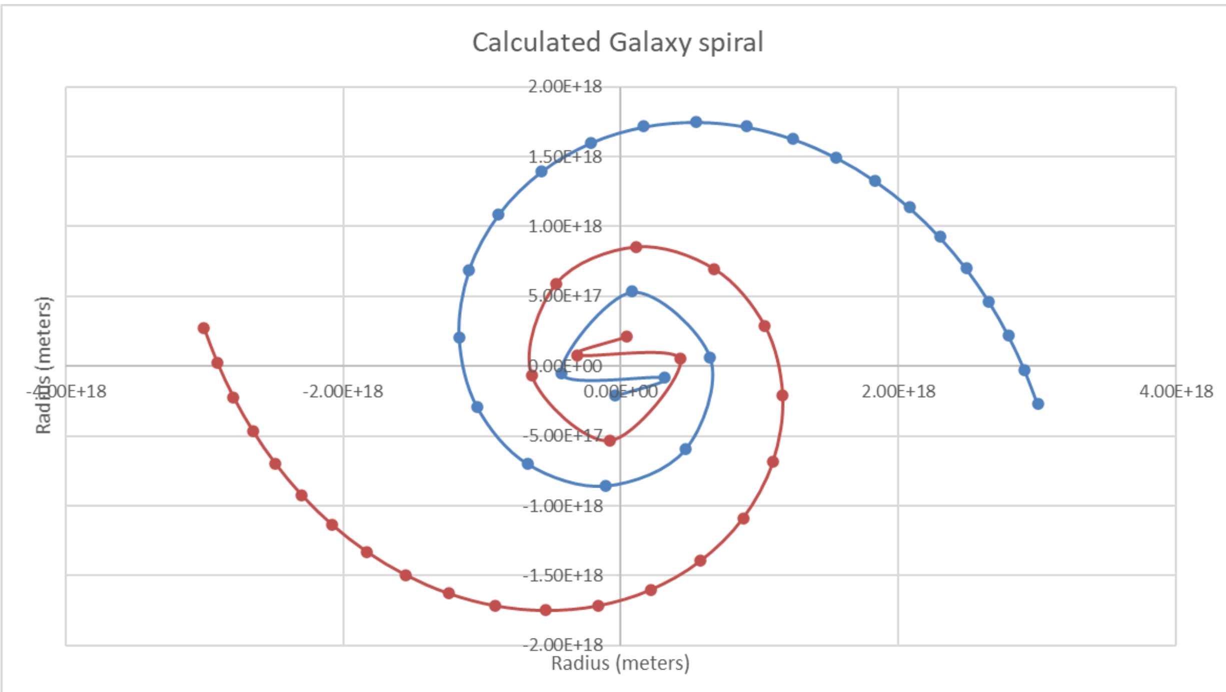




The gas that will become a star had a filament radius of about 5% of the filament length (see the simulated value s=5e16 meters and L= 1e18 meters in the table within topic “Mass accumulation in galaxies….”). The galaxy formed from these filaments will be a disk compared to a sphere.

The calculations for the stars added to the spiral galaxy is shown below:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mass of star | | | | | 2.63E+29 | 2.74E+29 | 2.86E+29 | 2.98E+29 |
| Radius at added star | | 1.13E+17 | increments | | 1.13E+17 | 2.25E+17 | 3.38E+17 | 4.50E+17 |
| rbefore fall=7.045e-14*10.15/ke*(2.1e8*Mstar/1.67E-27)*1/EXP(90) | | | | | 3.51E+16 | | | |
| vbefore fall=(6.67e-11*2.1e8*Mstar/rbefore fall)^0.5 | | | | | 5.09E+04 | | | |
| Vorbital=(6.67e-11*(2.1e8*Mstar)/R)^0.5 | | | | | | 1.31E+05 | 1.09E+05 | 9.62E+04 |
| Vconstant=(6.67e-11*(2.1e8*4.5E+25)/(rbeforefall))^0.5 | | | | | 4.70E+03 | | | |
| angle change at R= (Vo-v)/Vconstant | | | | | | 1.70E+01 | 1.23E+01 | 9.64E+00 |
| R cos (theta) | | | | | | -6.82E+16 | 3.29E+17 | -4.40E+17 |
| R sin (theta) | | | | | | -2.14E+17 | -7.51E+16 | -9.56E+16 |

The last two rows just allow the excel® program to plot in polar coordinates.  A familiar looking galaxy with two arms is shown below.




## Conclusions

### *The cosmic web*

As Yogi bear said, "it is difficult to make predictions, especially about the future".  Predictions about the universe are models of the past and the more accurately they agree with observations the more valuable they are.  Yogi might have said, "it is difficult to make predictions, especially about things you can't see".  The proton model has been successfully applied in many areas [3][4][5][7][10] and this extends its predictive power to the cosmic web.  It is based on the Schrodinger equation [19] and is explanatory of a beginning that occurs with zero energy and probability 1.  It appears to be an energy/probability "bot" that creates everything through separation.  This was described as particle-space in reference 13 since it contains the source of time and space, anchors the gravitational [6] [Appendix 2] constant and contains conservation rules related to expansion of the universe.  The proton model conserved energy kinetic energy plus potential energy = 20.3 MeV is the basis of the expansion model called R1+R3. A model of accumulation is reported in this document and its companion reference 16. Filaments are an effective process for mass accumulation and may be the cosmic web. They are low diameter after falling into their orbital radius and are only recently lighting up with fusion. They could have been the backbone of structure formation earlier even though they are difficult to detect.

The galaxy spirals that “fall out” of the calculations look very real.

### *Dark matter is not required*

Many consider the baryon content of the universe to be severely limited (0.046 baryon fraction of critical density) by the following reported [11] considerations: Firstly, primordial residual deuterium measurements were thought to be inconsistent with high baryon content. The author showed a model that agrees with deuterium residuals at critical density [8]. Secondly, the point where equality of matter and radiation occurs was thought to limit baryons. Again, the model shows equality at density equivalent to 1.0 baryon fraction of critical density. Lastly, the hot spots in the cosmic background radiation point to density and wavelength as the main variables that predict delta temperature. Dark matter does not appear to be a factor and should not limit baryon content. It is believed that current normal matter has density of 9.13e-27 Kg/m^3, a value known as critical density. This density and the R1+R3 model are consistent with the measured Hubble constant measured by WMAP of 2.2e-18/sec.

### *Star velocity profiles*

Based on reference 12, astronomers should expect the flat velocity profiles they measure. Stars can orbit at any velocity dependent on their total kinetic plus potential energy. There is no need for dark matter.

### *Dark energy*

Late in expansion, energy addition from star fusion is adequate to explain the Hubble measurements. A cosmological constant is not required.

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## Appendix 1 **The proton model**

The proton model is shown below (I believe it is consistent with the standard model [10][5]). It is a list of energy components inside the proton that defines fundamental values and relationships. The left-hand side is mass plus kinetic energy and the right-hand side is the opposing and opposite field energy components. Toward the center of each particle diagram values called N are listed [13]. Energy is related to N by the equation E=2.02e-5*exp(N).

| Quark mass | Kinetic E | N=ln(E/2.02e-5) | | Field E |
|---|---|---|---|---|
| (MeV) | (Mev) | | | (MeV) |
| 101.95 | 646.96 | 15.43 | 17.43 | 753.29 |
| | 5.08 | 12.43 | 10.43 | 0.69 |
| 13.80 | 83.76 | 13.43 | 15.43 | 101.95 |
| | 5.08 | 12.43 | 10.43 | 0.69 |
| 13.80 | 83.76 | 13.43 | 15.43 | 101.95 |
| | 5.08 | 12.43 | 10.43 | 0.69 |
| Weak Void | -20.30 | | | |
| Weak KE | 0.00 | | | |
| Balance | 0.00 | | | |
| Neutrino ke | -0.67 | | 10.51 | 0.74 |
| ae neutrino | -2E-05 | | | |
| E/M field | -2.7E-05 | | | |
| 938.27 | MeV Proton | | | |
| | 2.72E-05 | 0.296 | | |
| | -0.6224 | -10.33 | | |
| 0.5110 | 0.11 | 10.14 | | |
| electron neu | 2.02E-05 | | | |
| Neutrino ke | 0.67 | 10.41 | | |
| | 0.74 | | | |
| expansion pe | 10.15 | | | |
| expansion ke | 10.15 | | | |
| 959.99 | | | | 959.99 |
| Total N values | | 90.10 | 90.10 | |

The quarks transition to lower mass, conserving overall energy.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | P=1=exp(itE/H)*exp(-itE/H) | | | | | |
| | E | | | | | E | | |
| | Mass plus | | | | | Strong Field Energy | | |
| | Kinetic Energy (MeV) | | | | | Gravitational Field Energy | | |
| | E=2.02e-5 | Diff KE | N | P | N | E=2.02e-5*exp(N) | | |
| Down Qua | **4.36** | 744.55 | **15.43** | **1** | 17.43 | **753.29** | Down Strong Field | |
| Kinetic E | | 5.08 | 12.43 | | 10.43 | **0.687** | Grav Field component | |
| Up Quark | **2.49** | 95.07 | **13.43** | **1** | 15.43 | **101.95** | Up Strong Field | |
| Kinetic E | | 5.08 | 12.43 | | 10.43 | **0.69** | Grav Field component | |
| Up Quark | **2.49** | 95.07 | **13.43** | **1** | 15.43 | **101.95** | Up Strong Field | |
| Kinetic E | | 5.08 | 12.43 | | 10.43 | **0.69** | Grav Field component | |
| neutrino k | -0.671 | | | | | | | |
| borrow | | -30.45 | -10.33 | | -0.62 | | | |
| Strong residual KE | | 10.151 | 0 | | | | | |
| ae neutrin | -2E-05 | | 0 | **1** | 10.507 | 0.740 | Grav Field component | |
| E/M field | -2.72E-05 | | | | | | | |
| Proton M | 938.2720 | | | | | | | |
| E/M field | 2.72E-05 | | 0.296 | | | | | |
| electron | 0.511 | | 10.136 | | | | | |
| Kinetic E | 0.111 | | | | | | | |
| v neutrino | 0.671 | | 10.408 | | | | | |
| t neutrino | 0.740 | | 0 | | | | | |
| e neutrino | 2.02E-05 | | 0 | | | | | |
| Fusion release | | 0 | | | | | | |
| Expansion | outside | 10.151 | | | | | | |
| Expansion | Proton | 10.151 | | | | 2.801 | Grav Field Total | |
| Total M+K | 959.9855 | sum m+ke | 90.10 | | 90.10 | 959.986 | | |

The bottom part of the diagram above shows energy outside the proton. This part represents space. The right two columns contain field energy values. Overall, the diagram indicates that total mass and kinetic energy is equal and opposite total field energy 959.99 MeV

## Comparison of proton model and PDG data

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Compare the above values for the neutron and proton with measured values. | | | | update feb 2017 | | | | | |
| 931.4940281 | nist | | 0.510998946 | 0.510998946 | | | | | 1.30E-07 |
| 931.4940955 | pdg | 548.5799095 | 0.51099895 | | 0.5110011 | | -2.15856E-06 | | 2.40E-07 |
| simple cell g67 | Data | | Data (mev) | | Calculation (mev) | calculation | Difference | Difference | measurement |
| | | | Particle Data Group | | Present model | (amu) | (mev) | (amu) | error (amu) |
| | | (amu) | | (an | (mev) | | | | |
| Neutron | nist | 1.008664916 | 939.5654133 | 939.5654135 | 939.5654127 | 1.0086649 | 5.629623E-07 | 8.71281E-10 | 6.20E-09 |
| Proton | nist | 1.007276467 | 938.2720813 | 938.2720813 | 938.2720767 | 1.0072765 | 4.620501E-06 | 4.98855E-09 | 6.2E-09 |
| Neutron/electron | 1838.683662 | | 939.5654133 | nist | 939.5654127 | | 5.6296233E-07 | | |
| Proton/electron | 1836.152674 | | 938.2720814 | nist | 938.2720767 | | 4.6785007E-06 | | |

**Basis of the proton model: information theory probabilities**

The formal definition of information is attributed to Claude Shannon. Information (N) = -ln P (Inversely, P=1/exp(N) where exp(N) means the natural number 2.716 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). 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. 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 2.716. The energy constant e0=2.02e-5 MeV is calculated below from Particle Data Group 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 of reference 13. The data is either from NIST, (National Institute of Standards and Technology), the Particle Data Group maintained by UC Berkeley or other reported values. 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).

Probability 1=e0/exp(N). This probability is an energy ratio and leads to the equation E=eo*exp(N). The probability is 1/exp(N) and e0=1 in natural units or 2.02e-5 in MeV units, evaluated from the electron N.

Energy zero= 0= E-E. Energy is created by a separation but there are two types of energy. The proton model explains how energy separations from zero and probability 1 represent the neutron and proton. Probability 1 represents the other initial condition, zero information. Everything was apparently produced by separations. The components of the neutron and its fields encode the laws of nature. It means that there are particles separated in distance, each with kinetic energy for expansion of the universe.

The work below derives Schrodinger based orbits that obey energy zero. This means there will be positive and negative energy terms created through separation. This E=0 constraint and related P=1 constraint are further defined below.

There are sets of four probabilities of interest that contain exponential functions 1/exp(N).

P=e0/E=(h v0)/(h v)=v0/v=wl/wlo.

p=e0/E=1/exp(N), i.e. E=e0/p.

With p=1/exp(N), E=e0*exp(N).

E1-E1+E2-E2+E3-E3+E4-E4=0
Identify E as E=e0*exp(N), using the same N values as the LHS.

0=eo*exp(13.431)-eo*exp(13.431)+e0*exp(12.431)-e0*exp(12.431)+e0*exp(15.431)-e0*exp(15.431)+eo*exp(10.431)-e0*exp(10.431)

Mass plus kinetic energy will be defined as positive separated from equal and opposite negative field energy. E1 is the only mass term, E3 and E4 are field energy and the remainder is kinetic energy.

E1+(E3+E4-E1-E2)+E2-E3-E4=0 (rearrange)
E1 is mass, (E1+E4-E1-E2)+E2 is kinetic energy.
E3 and E4 are equal and opposite field energies
mass1 + kinetic energy- field energy3-field energy4=0

Probability=1/exp(N) is written below in tabular form. Information = negative natural log(p1*p2*p3, etc.) = 90.1 is written at the bottom of each fundamental N column. With these probabilities, the components become parts of the N=90 information system.

| | N | P=1/exp(N) | N | P=1/exp(N) |
|---|---|---|---|---|
| Quad 1 | **15.43** | 1.99E-07 | **17.43** | 2.69E-08 |
| | **12.43** | 3.99E-06 | **10.43** | 2.95E-05 |
| Quad 2 | **13.43** | 1.47E-06 | **15.43** | 1.99E-07 |
| | **12.43** | 3.99E-06 | **10.43** | 2.95E-05 |
| Quad 3 | **13.43** | 1.47E-06 | **15.43** | 1.99E-07 |
| | **12.43** | 3.99E-06 | **10.43** | 2.95E-05 |
| | | | | |
| Quad 4 | **10.41** | 3.02E-05 | **-10.33** | 3.07E+04 |
| | **-10.33** | 3.07E+04 | **10.41** | 3.02E-05 |
| Quad 4' | **10.33** | 3.25E-05 | **10.33** | 3.25E-05 |
| | **0.00** | 1.00E+00 | **0.00** | 1.00E+00 |
| | P1*P2*etc | 8.19E-40 | | 8.19E-40 |
| | ln (Ptotal) | 90.00 | | 90.00 |

The next level involves placing the probabilities in the Schrodinger equation to produce the neutron and proton.

The four N values discussed in the section entitled “Evaluating E” and their associated energy is called a quad. It is defined as the E values E=e0*exp(N) in a box to the right of each N value. The key to distinguishing mass (E1) from kinetic energy (E2) and two fields is shown below. The positions are not interchangeable.

| | |
|---|---|
| Mass | Field 3 |
| Kinetic Energy | Field 4 (G) |

| | | mev | | | mev | | |
|---|---|---|---|---|---|---|---|
| | | E=e0*exp(N) | | | E=e0*exp(N) | | |
| N1 | 13.43 | 13.8 | E1 mass | N3 | 15.43 | 101.95 | E3 field |
| N2 | 12.43 | 5.1 | E2 ke | N4 | 10.43 | 0.69 | E4 field |

E1=2.02e-5*exp(13.43)=13.79, E2=2.02e-5*exp(12.43)=5.08, E3=2.02e-5*exp(15.43)= -101.95, E4=2.02e-5*exp(10.43)= -0.69 (all in MeV).

Overall, E1+(E3+E4-E1-E2)+E2- (E3-E4) =0= (E1-E1)+(E2-E2)+(E3-E3)+(E4-E4) obeys the energy zero restriction. I call these diagrams energy zero, probability 1 constructs. They contain energy components of a quark.

Repeating the process for the quark quads and quads that lead to the electron yields the proton model above.

### Number of neutrons in nature

According to the neutron/proton model it is made of improbable components like quarks. The probability of particles that makes up the neutron are energy ratios, i.e. p=e0/E=1/exp(N), where e0 is a small constant. The constant e0 is evaluated below with data for the mass of the proton 0.511 MeV and its known N value 10.136. This means the set of N values gives the energy of its components through the equation E=e0*exp(N).

Evaluating energy E in the model requires consideration of overall probability, not just the probability of particles. Based on the model the components of mass plus kinetic energy add to N=90.0986 (I used N=90 in early work). The probability of each neutron is 1/exp(N).

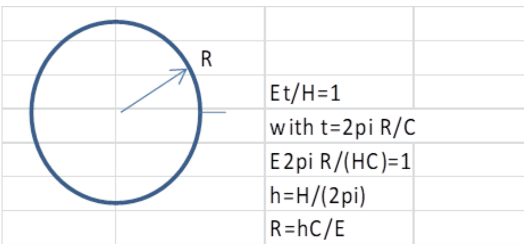
With mass plus kinetic energy components equal to P=1/exp(90) and equally improbable field energy components, the probability of the neutron is 1/exp(180) since probabilities multiply. But using probability from the proton model indicates that P=1 is recovered by duplication. Does this mean there is one neutron/proton expressed as exp(180) low probability duplicates throughout nature? But we know that neutrons exist and when something is certain, its probability is unity. An improbable event will occur if you “roll the dice” many times. The separation processes characterized by N=180 is rebalanced to an initial condition represented by probability=1. The “big bang” duplicates the zero based neutron exp(180) times. The component energies are constant so the dice roll “neutron” every time. These are apparently placed outside of each other to prevent nature from occurring as one large superposition. Is this the origin of the Pauli exclusion principle? The value exp(180) agrees roughly with estimates of critical density. (There have been several projects (COBE, WMAP [11][19], HSST, and PLANCK) and earlier work [4][10] that yield a great deal of information about the huge number of protons in nature).

## Appendix 2 Gravitational relationships in the proton model

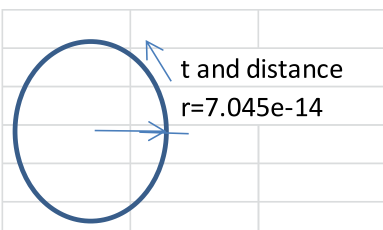
General relativity was a solution to a basic problem (action at a distance) in physics and is correct but it did not fully bridge the gap between large scale gravity and quantum physics.

The gravitational field energy 2.801 MeV from the proton model is used in a Schrodinger wave function [9][13]. Collapse of the wave function at P=exp(i*2.801*t/H)*exp(-i*2.801*t/H)=1 is a circle diagrammed below (imaginary vertical axis).

Et/H=1 where H = Planck's constant = 4.14e-21 MeV-sec leads to R= quantum circle radius= HC/2pi=1.973e-13/2.801=7.045e-14 meters. I consider this fundamental space.




Time also originates with this quantum circle. Et/H=1 with t=2pi r/C leads to r=HC/(2pi)/E. Time repeats around this circle in increments of 2pi R/C= 1.47e-21 seconds.




## Origin of the gravitational constant G

The gravitational constant G is a combination of values found in the proton model. The values are: kinetic energy 10.15 MeV, fundamental radius 7.045e-14 meters and the mass of protons (1.67e-27 kg). The N values in the model define the probability of one proton p=1/exp(90)*1/exp(90)=exp(180). Probability 1 is recovered with exp(180) protons (described more fully in Appendix 1).

### Cellular cosmology

Consider large mass M broken into exp(180) protons 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. 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 [10] 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 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.

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

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”. I call this cellular cosmology.

It must be recognized that for equal gravitational constant the radius of curvature and mass are vastly different between the large and small scale. It was unfortunate that the great physicists of the 1900’s did not have the advantage of WMAP [11] data, nor did they have the advantage of knowing the approximate number of protons in the universe.  Perhaps they couldn't compare cellular scale space to large space because they lacked information.

## Calculating the gravitational constant, G

The cumulative effect of exp(180) central protons curve space into a large sphere with radius 7.045e-14*exp(90)=8.59e25 meters.  The large numbers can be combined into the factor 1/exp(90).  This yields the relationship below between two protons [6].

| | | | |
|---|---|---|---|
| **G=10.15124*2*7.045e-14*1.602e-13/EXP(90)/1.675e-27^2** | | | |
| **6.69E-11** | Grav Const Nt m^2/Kg^2 | | |

The factor 1/exp(90) is recognized as a bridge between large scale Newtonian physics and the quantum scale.  The value 1.6e-13 Nt-m/MeV in the equation is a conversion constant.  With kinetic energy (ke)=10.15 MeV and r0=7.045e-14, the equation above can be used to define how the radius of a cell changes with kinetic energy.  A cell is the space that one proton defines, a concept called particle-space.   Newtonian gravity is in complete alignment with the concept of particle-space [13].  With G constant, radius R expands as kinetic energy is converted to potential energy.

| | |
|---|---|
| G=2*ke*r0/m^2*1.6e-13 | |
| G=G as R increases | |
| 2*10.15*r0/m^2= 2*ke*R/m^2 | |
| 10.15*r0= ke*R | |
| R=r0*10.15/ke | |

This means that the proton model is more descriptive than Newtonian gravity alone because kinetic energy is a property of proton and the space it defines (this makes the proton a widget producing expansion).  Expansion occurs as kinetic energy is converted to gravitational potential energy.  The above relationships can be further expanded as follows:

| |
|---|
| Orbital R for galaxy= GM/V^2  where M is the central mass |
| substitute G=r0 v^2/m*(1/exp(90)) |
| R= r v^2/m*(1/exp(90))*M/V^2 |
| v^2/V^2=1 (cell v and large V equal) |
| m/M=m/(m*number of cells in galaxy) |
| R= r*(1/exp(90))*M/m |
| multiply top and bottom by exp(180) |
| R=r*exp(90)*M/(m*exp(180)) |
| m*exp(180)=Muniverse |
| R=r*exp(90)*(Mgalaxy/Muniverse) |
| r=r0*10.15/ke=7.04e-14*10.15/ke |
| R=7.04e-14*10.15/ke*exp(90)*(Mgalaxy/Muniverse) |
| |
| **R=r0*10.15/ke*(Mgalaxy/1.67e-27)*(1/exp(90))** |

For a filament of Mgalaxy with a radius to length ratio of 0.05, M above will by Mgalaxy*.05. R will be proportionally lower (if mass is along a line, it isn't central).

The above equation equals R=GM/V^2 but kinetic energy is a specific value associated with particle-space.

## Appendix 3 Expansion model based on proton model

Understanding that the gravitational constant G can be calculated with ke0= 10.15 MeV/proton of kinetic energy in a cell of radius r0= 7.045e-14 meters allows further development of cellular cosmology gravitational relationships before thermodynamics starts to dominate. As kinetic energy decreases and potential energy increases each cell expands. Kinetic energy associated with each of exp(180) cells is related to pressure acting outward on the surface. Consider how kinetic energy and potential energy change in the derivation below. Kinetic energy (ke) is be turned into gravitational potential energy (pe=Fr) over time. The increasing radius of the universe and increasing time are related through expansion.

| Kinetic E | Potential |
|---|---|
| ke | F r |
| 1/2M(v)^2 | GMM/r |
| 1/2M(r/t)^2 | GMM/r |
| 1/2Mr^3/t^2 | GMM |
| 1/(2GM)*r^3 | t^2 |

(r/r0)^3 increases as (t/t0)^2

(r/r0) increases as (t/alpha)^(2/3)   (kinetic energy requirement).

Returning to the basic concept that particles define space locally, the above equations indicate that time is changing two things simultaneously. 20.3 MeV= ke+pe. Combining the equations above:

(r/r0)=(t/alpha)^(2/3)
With r= r0*10.15/ke
r/ro*10.15/ke= (t/alpha)^(2/3)
ke=10.15/(t/alpha)^(2/3)
pe=20.3-10.15/(t/alpha)^(2/3)

These can be substituted into the space portion of the model as follows:

| | | | |
|---|---|---|---|
| | 2.72E-05 | 0.296 | |
| | -0.6224 | -10.33 | |
| 0.511 | 0.11 | 10.14 | |
| electron n | 2.02E-05 | | |
| Neutrino k | 0.67 | 10.41 | |
| | 0.74 | | |
| expansion | ke=10.15/(t/alpha)^(2/3) | | |
| expansion | Pe=20.3-ke | | |
| 939.68 | | | 959.99 |
| Total N values | | 90.10 | |
| r=7.045e-14*10.15/ke | | | |

With this understanding the proton model describes expansion with time. Since time is defined by the proton and it also contains expansion kinetic energy, the proton becomes a cosmological particle with the full capability of representing the universe we see around us. Particle-space is a cosmological model.

| | | | | Start | He4 transition | He4 Spike | R1 | R3 stars |
|---|---|---|---|---|---|---|---|---|
| | Time (seconds) | | | 0.0515 | 438.8 | | 4.352E+17 | now |
| | KE MeV | | | 10.15 | 0.099 | 2.81E+00 | 3.24E-10 | |
| 2.7115883 | KE expansion algorithm | | | 10.15*(0.0511/time)^.5 | | 2.81*(539/time)^0.666 | | |
| 2.0426E-16 | Expansion Time (sec) | | Time (sec | 0.052 | 539 | 539 | 4.32E+17 | |
| 3.526E+25 | Temp before He4 spike K=ke/(1.5*B) | | | 7.87E+10 | 7.66E+08 | | 0.355 | settle back r |
| 2.131E+33 | R meters=8.05e12*10.15/(E*pi) | | | 8.04E+12 | 8.26E+14 | | | |
| 1.188E+16 | R after spike=8.23e14+2.8*1.6e-13/(3.6e-42*exp(90)*exp(60) | | | | | 1.20E+16 | 3.70E+25 | 4.16E+25 |
| 2.178E+10 | Temperature after He4=KE/(1.5*B) | | | | | 2.18E+10 | 2.51 | 2.73 |
| | baryon photon ratio | | | | | 6.98E-10 | | |
| | | | Stars energy delta radius (m) | | | | | 4.6E+24 |

The table above is a summary of expansion based on energy values in the proton-space model. This is fully discussed in references 8 and 12. Expansion starts based on ro=7.045e-14*exp(60) meters (exp(180) particles in three dimensions). The original expansion energy 10.15 MeV and associated temperature decrease until the temperature associated with 0.111 MeV is reached. This value is found in the proton model as 0.622 MeV-0.511 MeV= 0.111 MeV. Neutrons and protons are in equilibrium at the beginning but neutrons start to decay with a half time of 660 seconds. There are enough neutrons remaining at energy 0.111 MeV to readily react with protons. About 25 percent of everything becomes He4. This spikes the temperature but as expansion continues it falls to near present values. The proton energy components and its gravitational relationships create the cosmology we observe over time. A comparison was made with finding of WMAP [11]. There are substantial differences that were addressed in reference 8.

## Appendix 4 Fusion model for the sun

Details are in references 3 and 4. Fusion is considered a multiple of three probabilities, P barrier, P density and P reaction rate. P barrier is a property of the atoms reacting.

| Sun example | | | | |
|---|---|---|---|---|
| Temp | deg K | 1.32E+07 | Dmax kg/m^3 | |
| Density | kg/m^3 | 1.15E+06 | 5.288E+11 | |
| KE temp | 1.5*B*T | 1.704E-03 | | 8.620E-11 |
| degeneracy | | 7.51E+00 | | 5.2911E-11 |
| Degenerate radius (DR) | | 7.040E-12 | | |
| v/c | | 0.081 | | |
| Barrier | | -0.0136 | | 0.00000 |
| Example calculation for above conditions | | (1.2e5/5.28e12) | | |
| rate | | Pbarrier | Pd=(dens/ma | Preaction rate R/sec |
| Probability/sec | | exp(-.0136/ke temp) | | v/C*C/(2pi*degenerate radius)/exp(60) |
| 3.59E-18 | | 3.42E-04 | 2.17E-06 | 4.839E-09 |
| burn time (Byrs) | | 8.8 | | |
| sun N | | 1.198E+57 | 2e30 Kg/1.67e-27 | |
| fract burning | | 0.082 | | |
| burn rate N/sec*mev/N | | 3.53E+38 | | |
| power mev/sec | | 2.36E+39 | | |
| | | 3.8e26 joules/sec | wiki | |
| | | 2.37E+39 | mev/sec | |

## Appendix 5 Spherical mass accumulation

A review of the reference 16 spherical accumulation is included below. Spherical accumulation from a central mass applies particularly well to galaxies and clusters. Star accumulation is best modelled with filamentary (web like) mass accumulation described in the text.

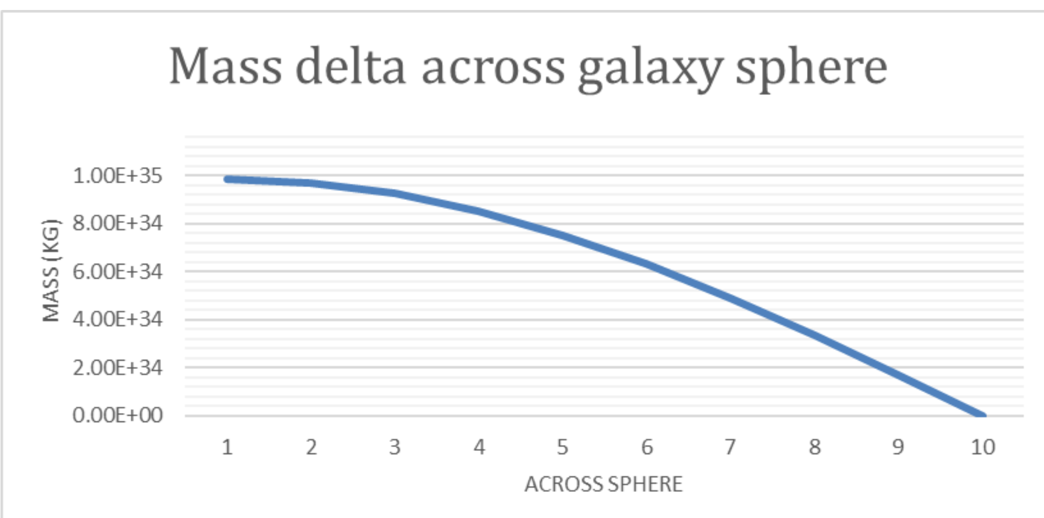
Central mass from d/d'=8e-6 density variations causes mass around it to accelerate toward its center. The equation is derived as follows:

| Touch down equation | | |
|---|---|---|
| | | |
| D=at^2/2=1/2*GM/D^2*(2D/at)^2=GM/(at)^2 | | |
| at^2=2GM/(at)^2 | | |
| a^3*t^4=2GM | | |
| a=(2GM/t^4)^.333 | | |

D is the distance mass can travel under acceleration a. Delta time (t) is incrementally calculated based on time increments in an expansion model. Velocity (at) and radius (D=2Gm/(at)^2) are substituted into the equation for acceleration. The equation can be simplified to a=(2GM/t^4)^(1/3). This is the acceleration that mass experiences as it gravitates toward the central mass M.

Acceleration (a) acts over a time increment (in an expansion model) to move mass from the virgin density around it toward the central mass. The radius that acceleration can influence is given by D=0.5*a*(t^2), where (t) is incremental time. The volume it influences is V=4/3*pi*D^3. The volume is multiplied by density to determine how much mass accumulated in time increment (t). This mass is accumulated in an incremental expansion model.

Calculations show that mass accumulates too slowly to explain structure formation (clusters/galaxies) if the central mass is a single 1.67e-27 Kg proton. It will accumulate as observed based on central mass density perturbations and the way orbits change as mass falls to lower orbits.




Mass moving toward the central mass is somewhat like an ice-skater bringing her arms toward her body.

| | | | |
|---|---|---|---|
| r=r0*10.15/ke | | | |
| ke=.5 m V^2 | | | |
| r=r0*10.15/(.5*m*V^2) | | | |
| r*(0.5*mV^2)=r0*10.15=constant | | | |
| Rfinal will be the smaller orbit with Vfinal | | | |
| (Vfinal is larger) | | | |
| Rinitial*(0.5*mVinitial^2)=Rfinal*(0.5*mVfinal^2) | | | |
| Rinitial*(Vinitial^2)=Rfinal*(Vfinal^2) | | | |

The original R will fall to a smaller orbit at Rfinal but the smaller orbit will have a larger Vfinal^2. This conservation law is integrated into calculations for the falling mass. Another definition is helpful: Rfinal=Rinitial*fall ratio. Fall ratio simply indicates that a large orbit can fall to a smaller orbit if the conservation rule is obeyed.

The strategy of the calculations below is to find the radius at which acceleration of mass falling in a gravitational field (A=GM/Rf^2) is equal to inertial A= Vf^2/Rf. The orbital velocity after falling into the gravitational field is Vf in the calculations below. The strategy sets the opposing accelerations equal at 8 m/sec^2. Final kinetic energy can be calculated from Vfinal.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| M central | | For each cell: | | 3.00E+54 | 9.84E+34 | 9.84E+34 | 9.84E+34 |
| M cum | | fall ratio 1 | 0.00222 | 5.40E+60 | 1.78E+35 | 3.09E+35 | 2.59E+37 |
| | | | 0.00222 | 2.22E-03 | | 1.06E+05 | 1.06E+05 |
| a | | Galaxy | 0.00222 | | 1.23E-08 | 8.82E-09 | 6.35E-09 |
| L=at^2/2 | | | | ke=1.5 k t | 1.68E+16 | 1.98E+16 | 2.34E+16 |
| | | | | area | | | 1.93E+33 |
| dm | | | | | 7.99E+34 | 1.31E+35 | 2.56E+37 |
| fall ratio | | | 2.18E-02 | 1.15E+39 | 6.50E-02 | 6.50E-02 | 6.50E-02 |
| Ru | | | | | 2.47E+22 | 2.91E+22 | 3.44E+22 |
| | | | | | | | |
| Mass. M (Kg) | | | | | 9.84E+34 | 9.84E+34 | 9.84E+34 |
| Ri=7.045e-14*10.15/ke initial*(M/1.67E-27)*1/EXP(90) | | | | | 1.60E+15 | 2.53E+15 | 2.53E+15 |
| Rf=7.045e-14*10.15/ke initial*(M/1.67E-27)*1/EXP(90)*8e-4 | | | | | 1.04E+14 | 1.65E+14 | 1.65E+14 |
| Vi=(2*ke initial/1.67E-27*1.6e-13)^0.5 (m/sec) | | | | | 64290.86 | 51124.50 | 51124.50 |
| a=Vf^2/Rf (m/sec^2) | | | from star | | 3.97E-05 | 1.59E-05 | 1.59E-05 |
| ke initial (MeV) | | | 1.36E-05 | | 2.16E-05 | 1.36E-05 | 1.36E-05 |
| A=GM/Rf^2 (m/sec^2) | | | | | 6.06E-04 | 2.42E-04 | 2.42E-04 |
| Vf=((Vi^2*Ri)/Rf)^.5 (m/sec | | Observation | | | 2.52E+05 | 2.01E+05 | 2.01E+05 |
| a=Vf^2/Rf (m/sec^2) | | | | | 6.11E-04 | 2.44E-04 | 2.44E-04 |
| | | | | | 1.03E-14 | 1.03E-14 | 5.33E-14 |
| ke=6.67e-11*M*1.67E-27/Rf^2*Rf/2/1.6e-13 (MeV) | | | | | 3.29E-04 | 2.08E-04 | 2.08E-04 |
| ke=0.5*1.67E-27*Vf^2/1.6d-13 (MeV) | | | | | 3.32E-04 | 2.10E-04 | 2.10E-04 |

The enclosed distance (D) = 0.5*a t^2 = 1.98e16 and volume is 4/3*pi*(1.98e16^3). The accumulated mass for this time increment is mass= volume* increased density= 1.31e35 Kg shown by the arrow. The increased density is equal to virgin density/fall ratio^3.