Gene H. Barbee
September, 2014

Black Holes and Quantum Gravity

Abstract

Black holes are interesting to the scientific community. Observations indicate that remnants of stars that become black holes range from about 4 solar masses through about 20 solar masses. A supermassive black hole with mass 4.2e40 Kg has also been observed. Astronomers use x-ray emission and the bending of light around massive objects to study them and observations to date challenge physicists to extend their knowledge.

A layer by layer model of pressure, temperature, density and fusion power (MeV/sec) of the sun was developed and compared to a supermassive black hole with similar density and fusion kinetics. To simulate smaller black holes, the author developed a method of determining the pressure and density as a function of radius. Conditions at the core of small black hole are extreme enough to cause degenerate (relativistic) behavior of know forces. It was unknown however, whether collapse actually occurs. The author uses a cellular model of gravity, space, time, expansion, kinetic and potential energy at the quantum level [6]. Quantum gravity indicates that black holes do not involve a singularity.

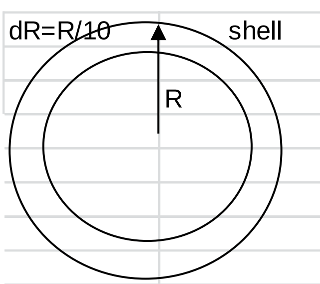
The Schwarzschild radius

Schwarzschild solved the metric equations for general relativity. His solution defining the radius S of a black hole was S=2GM/C^2 where: G=6.67e-11 nt m^2/kg^2, M is the mass of the central body and C is the speed of light. S' is half the S value defined and agrees with the geodesic radius. The geodesic is defined by the gravitational constant G=SV^2/M. The author defines a cell as the volume surrounding a single proton. Using S' to determine the radius of a black hole (BH), the average density, cell radius, cell kinetic energy and temperature can be determined for a series of BH's with increasing mass. Cell volume is the volume of the BH per proton. Volume BH=4/3*pi()*S'^3. Cell volume= (Volume BH/N cells) and cell radius = (Vcell/(3/4pi()))^(1/3) where N cells=M black hole/1.67e-27 kg.

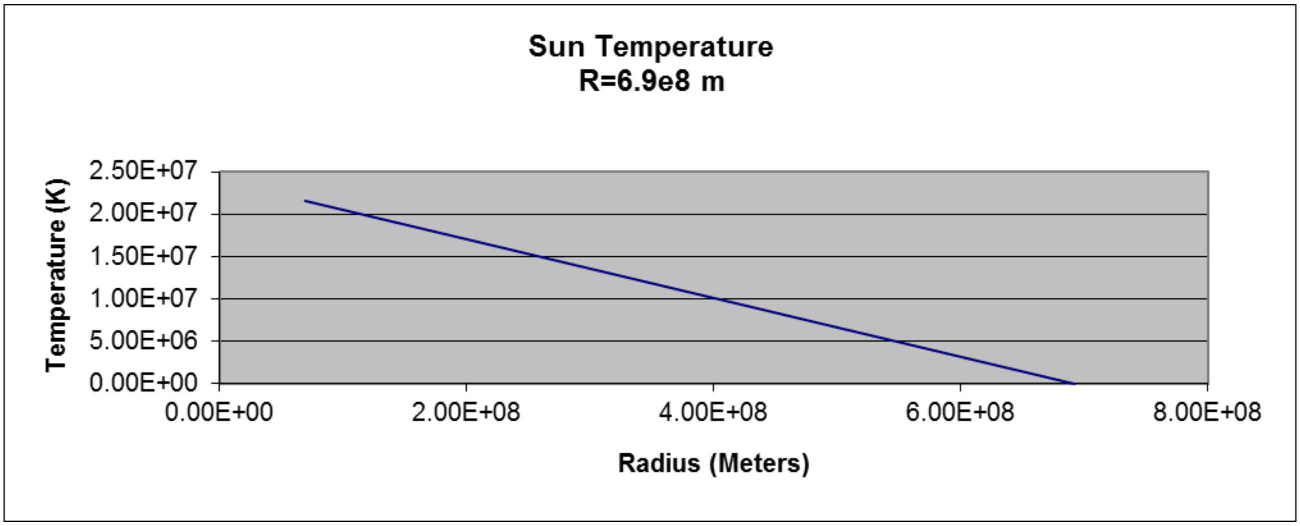
S=2GM/c^2=1.48e-27*m					
My Geodesic at C and High M					
S=2Geodesic					
			Minimum	20x solar	smassive
G nt m^2/kg^2	6.674E-11				
C m/sec	299792458	Kg	9.94E+30	4.00E+31	4.20E+40
S'=MC^2/2		S' meters	7.38E+03	2.97E+04	3.12E+13
Density	M/vol	kg/m^3	5.90E+18	3.64E+17	3.31E-01
		N cells	5.95E+57	2.40E+58	2.51E+67
		Vol cell (m^3)	2.83E-46	4.58E-45	5.05E-27
Average Cell Radius		Cell radius (m)	4.087E-16	1.034E-15	1.067E-09
S'/m=G/C^2	7.42583E-28				
proton m (Kg)	1.67E-27				

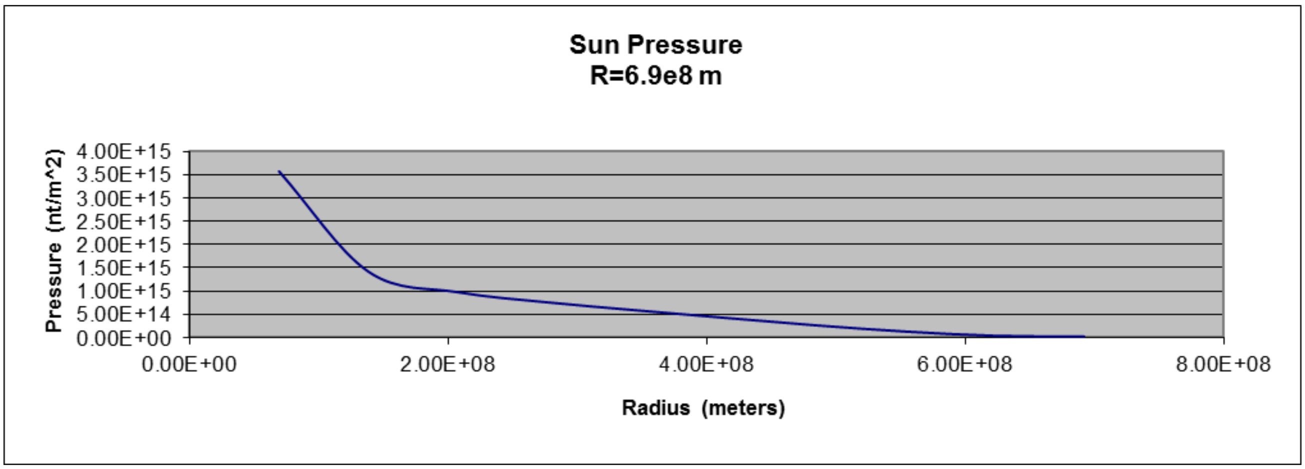
Approximate Solar Model

An approximate model of the pressure and temperature of the sun as a function of radius is shown below. It is based on breaking the sun into 10 radial shells each 1/10 of the full radius.



The mass above a shell surface is gravitationally attracted to the mass below the shell yielding acceleration a=G*Mcentral/R^2. At the bottom of each shell, the pressure is calculated as Pshell=acceleration*density*dR. Pressure adds down through the 10 shells until a central pressure is determined. Because the sun is about 4B years old, most of its early history has dissipated and temperature increases from the outside to the core due to nuclear power in the core. A linear relationship was assumed even though the radiation and convection zones conduct heat differently. The surface temperature is known (6e3 K) and the interior temperature is approximately 2e7 K. Density of each shell is determined by the equation rho=P/(R*T), where R is the gas constant for hydrogen 7980 nt-m/(Kg-K). Our sun has an interior density of about 1.2e5 nt/m^2 and the temperature and pressure profiles below produce this density in the interior. Here are plots for the model of the 2e30 Kg sun.





The core of the.10 shell model is in the chart below along with the equations. All 10 layers are in the appendix. The top of the core is at radius 6.92e7 meters and R is the sun's overall radius 5.9e8 meters.

P9 (nt/m^2)	P9=P8+rho8*a8*R/10		1.41E+15
rho9 kg/m^3	rho9=P9/(R*T8)		3.946E+04
h9 (m)	h9=h8+R/10		6.92E+07
T (K)	T9=T8+dT		2.160E+07
a9 (m/sec^2)	a9=6.673e-11*(M-m10)/(h9)^2		7.90E+02
mass shell Kg	m10=4/3*PI()*(h9^3-(h9-R/10)^3)*rho9		1.94E+27
cum mass	cumm10=cumm9+m10		1.943E+30
P10 (nt/m^2)	P10=P9+rho9*a9*R/10		3.57E+15
rho10 kg/m^3	rho10=P10/(R*T9)		8.869E+04
h10 core	h10=h9-R/10		0
r cell (m)	Cell radius	rcell=(1/rho10*1.67E-27/(4/3*PI()))^(1/3)	1.65038E-11

Again, the cell radius is the radius around each proton and is a function of density. The sun is dense enough at the core to make the electron degenerate because the cell radius is lower than the electron radius 5.29e-11 meters. The author uses a probability based model [9] [14] for fusion diagramed briefly in Appendix 2. The following table gives the fusion kinetics based on the pressure and temperature model above:

		sun model
2e30 Kg Solar Model		
	Max Dens	5.020E+11
Temp	deg K	2.16E+07
Density	kg/m^3	8.87E+04
KE	1.5*B*T	2.79E-03
degeneracy		3.20E+00
Degenerate radius (DR)		1.652E-11
v/c		0.104
Barrier		-0.0139
P barrier		6.90E-03
Pdensity		1.77E-07
Rate/sec		2.636E-09
Probability/sec		3.21E-18
burn time (Byrs)		9.9
N=m/1.67e-27		1.198E+57
fract burning		0.15
burn rate N/sec*mev/N		5.77E+38
power mev/sec		4.04E+39

It has a burn time of about 10 Billion years and generates about 4e39 MeV/sec.

Analysis of BH with 4.7 solar mass (9.9e30 Kg)

A black hole (BH) with 4.7 solar masses is quite different than the sun. To achieve BH status, the Schwarzschild radius S'=GM/C^2 for this 9.9e30Kg black hole was 7800 m, not 6.9e8 meters like our sun. This BH has a density of approximately 1.8e19 kg/m^3 and much higher temperature and pressure. Power generation in the sun increases the core temperature and lowers its density. But BH's of this size are burned out. The lack of nuclear power allowed the density to increase and it became a black hole.

Literature indicates the density of a BH is a function of pressure and suggests [15] the relationship: rho=(pressure/k)^(5/3). Wiki also indicates that temperature is not important. Pressure at the bottom of each shell is acceleration*rho*dR and accumulates down through the shells. Rho is the density of the layer, dR is the thickness of the shell and acceleration is G*Mcentral/R^2 where R is the radius to the center of the black hole and G is the gravitational constant. The core (10^{th} and inner most volume of the model) analysis is shown below. To conserve space only the core information is included.

Density starts with low density at the first shell interface and increases exponentially down through the layers. This puts almost the entire mass of the black hole in the core. The core pressure becomes 5.3e39 nt/m^2. The radius around each atom (cell radius) would be on the order of 5.5e-23 meters. This radius suggests to most physicists that there must be degenerate nuclear forces to prevent collapse.

P9 (nt/m^2)	P9=P8+rho8*a8*h0/10		1.38E+29
rho9 kg/m^3	rho9=(P9/1e16)^(5/3)		5.90E+21
h9 (m)	h9=h8-h0/10		7.38E+02
T (K)	T9=T8+dT		1.60E+13
a9 (m/sec^2)	a9=6.673e-11*(M-m8)/(h9)^2		1.22E+15
mass shell Kg	ms10=4/3*PI()*(h9^3-(h9-h0/10)^3		9.94E+30
cum mass	cumm10=cumm9+ms10		9.94E+30
P10 (nt/m^2)	P10=P9+rho9*a9*h0/10		5.30E+39
rho10 kg/m^3	rho10=(P10/1e16)^(5/3)		2.59E+39
h10 core	0		0.00E+00
r cell (m)	Cell radius	rcell=(1/rho10*1.67	5.36E-23
		C=(a*R19)^.5	9.48E+08

K in the equation rho=(P/k)^(5/3) was 1e16 since this allowed the mass of the layers to total 9.9e31 Kg.

Can rho= (P/k)^(5/3) be correct?

The author finds a major fault with the density equation (rho=(P/k)^(5/3)). The reason follows:

Schwarzschild S = GM/C^2. Turning this equation around, C=(GM/S)^0.5. Substituting in acceleration a=GM/R^2 and S=R, we have C=(a*R)^.5. Using the values above a=1.22e15 m/sec^2 and R=738 m, (a*R)^0.5=9.48e8 m/sec. Acceleration is too high and (a*R)^0.5 exceeds C. One can see that this implies R lower than S'=GM/9.48e8^2. The radius of each cell in the core would be extremely low at 5.3e-23 meters.

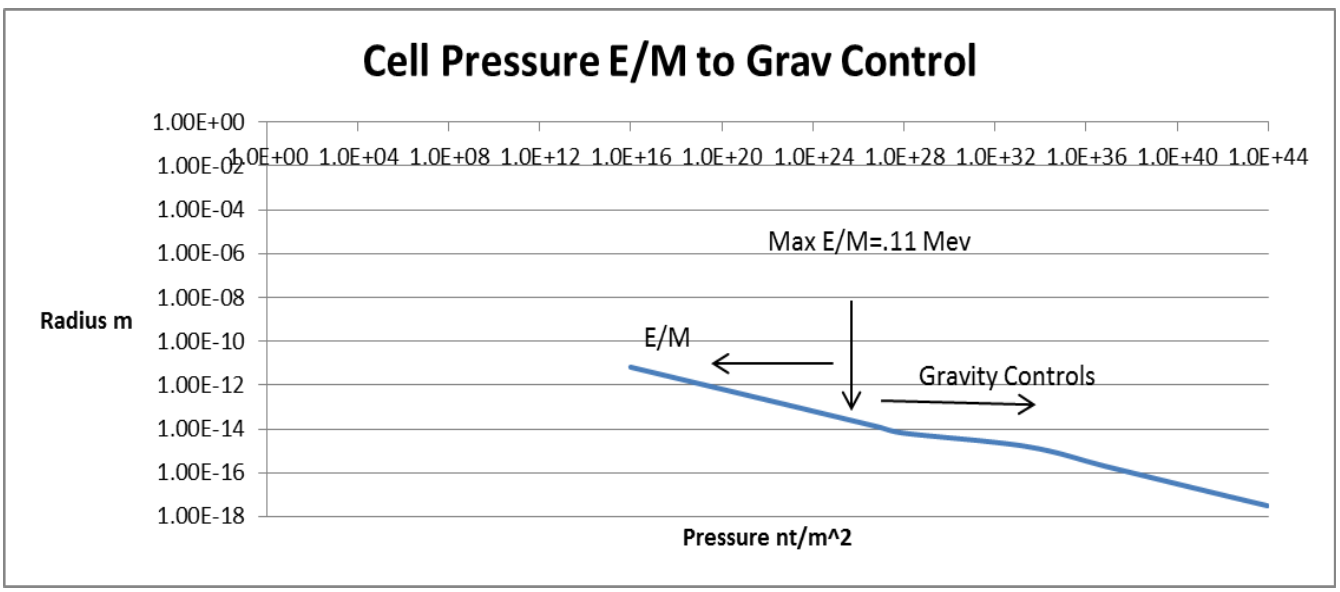
If we insist that C is not exceeded, the acceleration in each shell is a= C^2/R, where R is radius to the core. This means R is the Schwarzschild radius S' for each layer. In other words, each layer of the model is like the surface of the black hole and the velocity is C, i.e. (a*S')^0.5=C. Consider the alternative. If we let velocity at the layer's surface be less than C, the mass will not fit inside S' and it won't be a black hole. The other alternative is to let velocity exceed C. In the author's work, C is just the ratio between space and time and can't be violated. Another argument for this density relationship involves basic tenants of gravity. In special relativity gravity is the geometry of space-time and gravitational force is inertial force. The reason we feel force upward on the bottom of our feet is that our velocity is too low to be on a geodesic defined by the radius of the earth. We can calculate V to be on the geodesic. First we calculate our acceleration at the surface of the earth, a=G*Mearth/Rearth^2=9.75 m/sec^2. Next we calculate V=(a*R)^0.5= 7897 m/sec. The force upward on us is F=mass*a=m(V)^2/R. Force upward=mass*7897^2/6.38e6 nt. Force upward from the earth is making up for the outward inertial force we are missing because our velocity is too low. The equation could also be written F=mass*(7897^2-Vlow^2)/R. In this equation Vlow is fixed by us being on earth. Inside a black hole, V=C=(a*R)^0.5 and Vlow=zero; fixed by the fact that particles are inside the black hole. The equation becomes F=mass*(C^2-Vlow^2)/S'. The force is associated with velocity C and only light travels at C. The particles in the BH have no velocity, just temperature.

What resists collapse?

For gases at low pressure, the electron is circling the nucleus at radius approximately 5.29e-11 meters. Electromagnetic kinetic energy 13.6e-6 MeV resists the compression. A simple model of gas thermodynamics in shown below:

0.511	Electron Mass	mass MeV
9.11E-31	mass*1.78e-30 kg/MeV	mass kg
2.72E-05	E/M field energy	Field MeV
1.36E-05	ke	Kinetic Energy MeV
1.00E+00	g=m/(m+ke)	gamma=m/(m+ke)
7.30E-03	**V/C=(1-(f)^2)^0.5**	V/C
5.290E-11	r=electron orbital radius	Radius (meters)
8.24E-08	F=(m/g)*(v/C*C)^2/r	Force Nt
3.52E-20	area=4*pi*r^2	Surface area m^2
2.34E+12	P=F*area	Pressure nt/m^2
1.05E+05	ke/1.5/B	Temperature based on ke (K)
7829	R	Gas constant (nt-K/(m-kg))
2244	rho=P/(RT)	Density (kg/m^3)

When the radius decreases to the point where compression energy =0.11 Mev=13.6e-6*5.29e-11/6.4e-15 meters the electron no longer is sustained in the shell (Appendix 4 justifies the use of 0.11 MeV. Also read Wiki concerning White Dwarfs and Neutron Stars). At pressures higher than 9.6e27 nt/m^2 quantum gravity becomes the resisting energy and a chart similar to the one above is required.



We can understand quantum gravity as follows:

Fundamentals of space and time

Reference 6 identifies the source of the gravitational constant at the quantum level. The gravitational field energy 2.683 MeV from the Proton Mass model (Appendix 4) underlies the quantum mechanics for a fundamental radius r and a fundamental time t. In the equation below, the value 1.93e-13 meters-MeV is HC/(2*pi) where H is Heisenberg's constant 4.136e-21 MeV-sec and C is light speed, 3e8 meters/sec. The radius r is the radius of a quantum circle for gravity with 2.68 MeV field energy.

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

Gravitation

If radius r for the conventional physics (Wiki) force calculation is 7.35e-14 meters, as proposed above, the force in Newtons (NT) is:

F=(5.9068e-39)*hC/R^2				
	hbar		6.5821E-22	mev-sec
	hbar in NT-m-sec		1.05E-34	NT m se
	hbarC in NT-m^2=K		3.16E-26	NT m^2
F=(5.9068e-39)*K/R^2				
F=(5.9068e-39)*3.16e-26/(7.35e-14)^2=3.39e-38 NT				
3.453E-38	NT			

This result agrees with the simple Newtonian force for particles separated by 7.35e-14 meters.

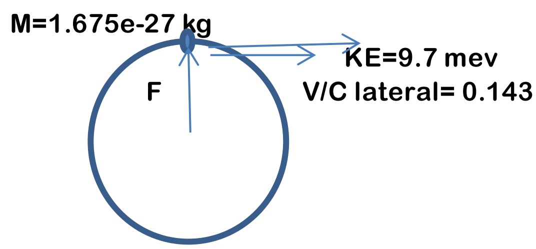
F=Gm^2/R^2 (NT)=6.67428e-11*1.6726e-27^2/7.35e-14^2=3.452e-38 NT where m is proton mass and R is meters.

Using values for the proton mass model that the author believes unify nature's forces (6), the gravitational constant is calculated below and agrees with the published constant, G=6.674e-11 NT meters^2/kg^2. The gravitational coupling constant 1/exp(90) derived above appears in the fundamental calculation for the inertial force in a cell that has cosmological properties.

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)^0.5			0.1428
R (meters) =(HC/(2pi)/(E*E)^0.5			**7.354E-14**
F (NT)=M/g*(v/C*C)^2/R/exp(90)			3.452E-38
HC/(2pi)=1.97e-13 mev-m			
Calculation of gravitational constant G			
Inertial Force=(M/g*C^2/R)*1/EXP(90)			3.452E-38
Radius R (Meters)			7.354E-14
Mass M (kg)			1.673E-27
G=F*R^2/M^2=NT m^2/kg^2			**6.674E-11**
Published by Partical Data Group (PDG			6.674E-11
PE fall MeV			19.34
Ke fall MeV			9.720
F =PE/R *1.6022e-13 NT			3.4524E-38
PE/R=(19.34*1.603e-13/7.3543e-14/exp(90))			

The use of 1/exp(90) and Heisenberg's uncertainty principle has the effect of dramatically reducing the force between protons and makes gravity very long range compared to the other forces. It also unifies special relativity and general relativity [6][13].

Defining gravity, time and distance together allows nature to use the general theory of relativity at the quantum level. The coupling constant 1/exp(90) scales the quantum level to the large scale we observe around us. Appendix 4 contains a review and origin of the coupling constant 1/exp(90). This is called cellular cosmology. A cell is diagrammed below.



The cell diagram shows an *outward* force F, identified with the gravitational inertial force. V/C is the velocity of a proton around radius, r. V/C originally is the gravitational kinetic energy 9.7 MeV from the proton model and G=rV^2/m is the geodesic. As the universe expands, kinetic energy KE decreases directly with radius. As it does so, the radius of each cell expands and exp(180) expanding cells define the space of the universe. Since kinetic energy decreases directly with radius, a geodesic is maintained and G is remains constant. Reference 13 analyzes expansion in terms of pressure and temperature. It concludes that pressure expands the universe and shows that 9.7 MeV of kinetic energy has been converted to potential energy intergral PdV= 9.7 MeV after expansion. The kinetic energy after expansion is very low and r for the diagram above is 0.55 meters. This gives the current Radius of the universe=0.55*exp(60)=6.3e25 meters. Further, reference 13 shows that kinetic KE in the cell diagram can be considered temperature. Using 9.7 MeV as the beginning energy and temperature T=ke/1.5/B (and adjusting it upward for primordial He4 fusion), the kinetic energy is now associated with the cosmic microwave background temperature (CMB) =2.73 K. Using ke=1.5BT (B is Boltzmann's constant 8.6e-11 K/MeV), the kinetic energy is now 3.5e-10 MeV. Knowing that KE in the cell diagram is temperature and that there is pressure inside each cell are key understandings used below.

Pressure inside cells keeps a black hole from collapsing

The cell must exert pressure to balance the lack of velocity in the particles above it because the particles are off their geodesic. Their velocity should be C and in fact it is near zero. But the quantum cell radius is a geodesic and particles on a geodesic exert outward inertial force. Pressure is determined by multiplying the force times the cell surface area. Each cell in the black hole has temperature and internal pressure. When cell radius r becomes less than 6.5e-15 meters the electromagnetic force is overwhelmed (see chart above in the section entitled "What resists collapse?") and the resisting pressure is based on gravity. Originally the star was hot and when the nuclear fuel was expended, it contracted creating compression energy. Temperatures on the order of 2e13 K occur in the bottom shell of the 9.9e30 Kg black hole. The kinetic energy associated with this temperature is 1.5*8.4e-11*2e13=2730 MeV. This is now the kinetic energy in the cell diagram above. Here is the gravitational model for the core pressure based on insisting that (a*R)^0.5=C: The full model is in the appendix but the core conditions are shown below and the radius of cell near the center of the 9.9e30 Kg black hole is 2.93e-16 meters.

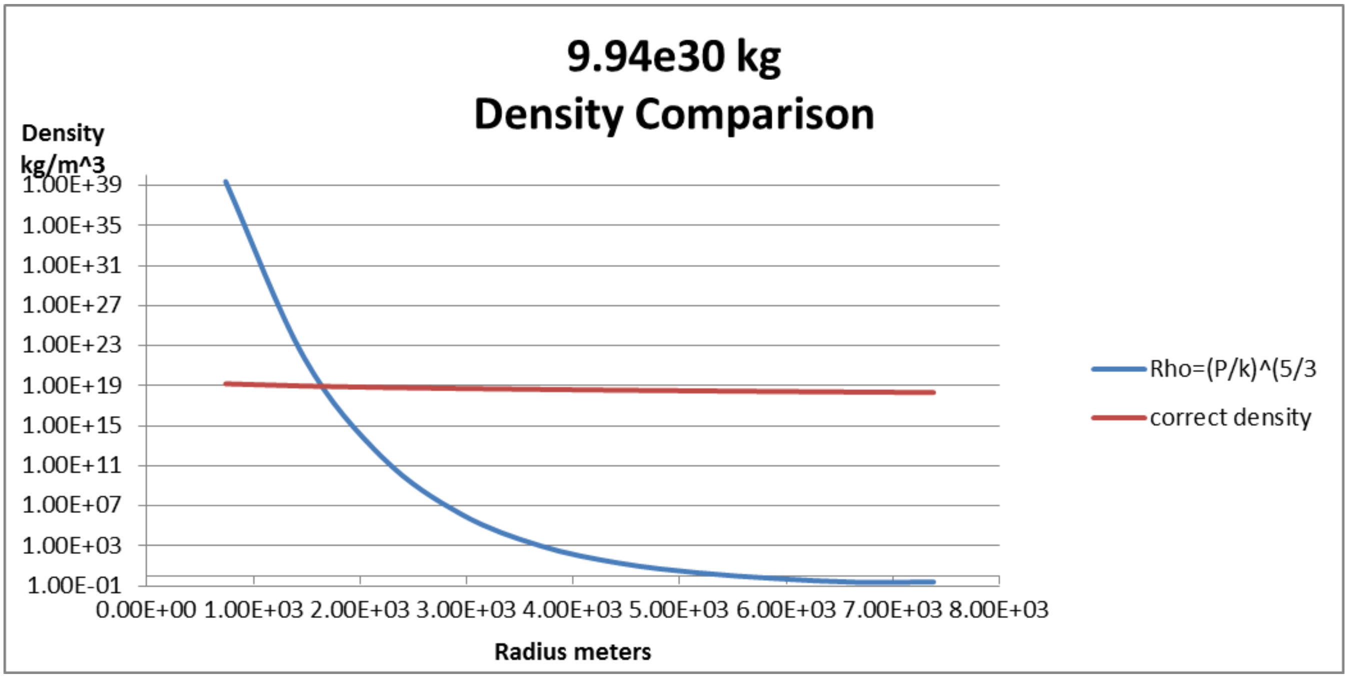
P9 (nt/m^2)	P9=P8+rho8*a8*R/10			8.82E+35
rho9 kg/m^3	rho9=1.67E-27/(4/3*PI()*((((4.9e-25)/(P9)))^0.2565)^3)			9.42E+18
h9 (m)	h9=h8-h0/10			7.38E+02
T (K)	T9=(9.7*7.34e-14/rcell)/1.5/8.6e-11			1.58E+13
a9 (m/sec^2)	a9=C^2/h9			1.22E+14
mass shell Kg	ms10=4/3*PI()*(h9^3-(h9-S/10)^3)*rho9			1.59E+28
cum mass	cumm10=a9*h9^2/G			9.96E+29
P10 (nt/m^2)	P10=P9+rho9*a9*R/10			1.73E+36
rho10 kg/m^3	rho10=1.67E-27/(4/3*PI()*((((4.9e-25)/(P10)))^0.2565)^3)			1.58E+19
h10 core	0			0
r cell (m)	Cell radius	rcell=(1/rho10*1.67E-27/(4/3*PI()))^(1/3)		2.93E-16
		C=(a*R9)^.5		3.00E+08
				small cmax
				proton
		mass MeV		**938.2720**
		mass kg		**1.673E-27**
		Field MeV		**2.683**
Kinetic Energy		KE=9.7*7.34e-14/2.93e-16		**2432.950**
gamma		g=m/(m+ke)		**0.2783**
		V/C=(1-g^2)^0.5		**0.9605**
Radius		R=rcell		**2.932E-16**
Force Nt		F=m*V^2/R/exp(90)		**1.392E-33**
Cell surface area m^2		area=4*pi*R^2		**1.081E-30**
Pressure nt/m^2		F*area*exp(90)		**1.573E+36**

Note: the equation for density is developed in appendix 3.

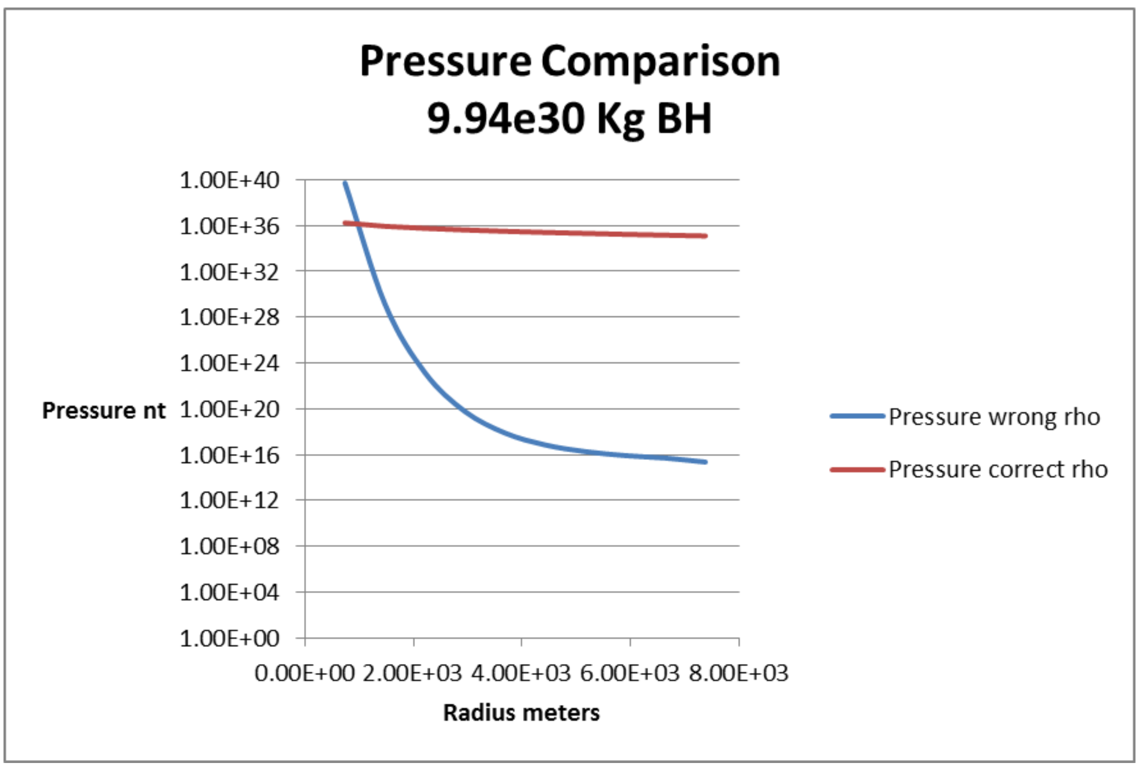
Recognize the bottom part of the above diagram as the quantum gravity calculation except radius has been reduced by a factor of about 250=7.34e-14/2.93e-16. Since cellular quantum gravity keeps G constant, kinetic energy varies with radius, the kinetic energy has increased by a factor of 250 and is approximately 2430 MeV. The equation is 9.7*7.34e-14/2.93e-16 MeV=2430 MeV. But the compression temperature in the core was 2.4e13 K and 2.4e13/1.5/B=2430 MeV. Pressure in the cell is calculated by taking force*cell surface area. The outward pressure 1.4e-33 nt/m^2 exerted by the cell resists the pressure near the center of the black hole (1.57e36 nt/m^2) and prevents it from collapsing. The energy is a natural outcome of the temperature resulting from compression and does not need to be associated with degeneracy. Gravity resisted pressure involves temperature but temperature, pressure and density are intimately linked. This allowed the author to develop the equation below for rho. It is based on solving the gravity equation for cell radius and determining rho from cell radius. It is based on known equations but fits an empirical relationship (Appendix 3) within 8% over black hole pressures investigated. (The equation is a computational convenience).

rho=1.67E-27/(4/3*PI()*((4.8E-25/P)^0.2565)^3)

Below is a comparison of the two density relationships.



Below, the pressure is compared for the two density relationships. Note that the central pressure is lower using the correct rho.



The question might be asked, does compressing the radius cause the gravitational constant to change? Actually, the fundamental radius is r=9.17e-13 mev-sec/(2.683*2.683)^.5=7.34e-14 meters. This radius does not change because the field energy 2.683 MeV is set by the Proton mass model. Gravitational constant G is maintained by the relationships in the proton mass model. The cell relationships maintain an approximate G but G=F*R^2/(M/g)^2 may decrease slightly if we consider that M/gamma increases because of temperature related velocity.

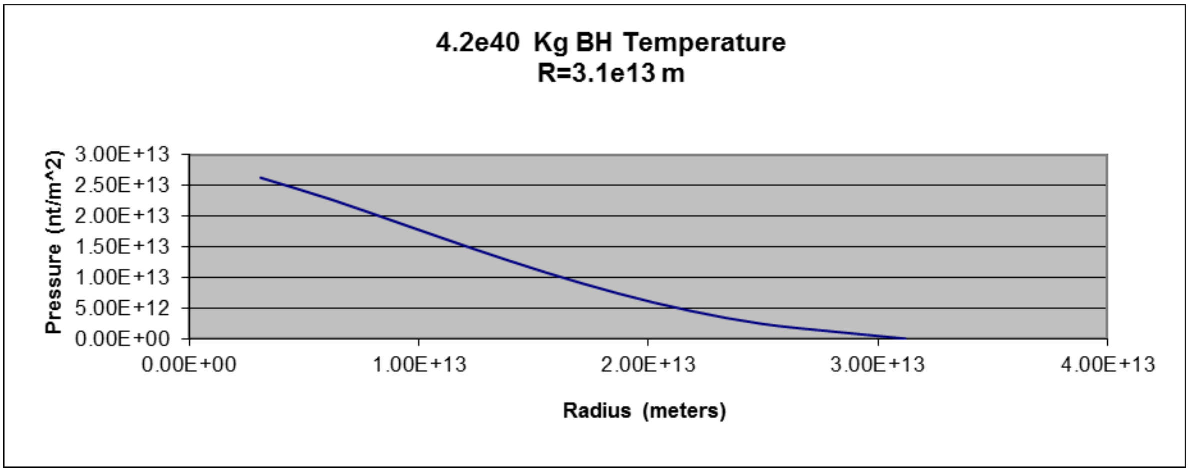
More massive black holes

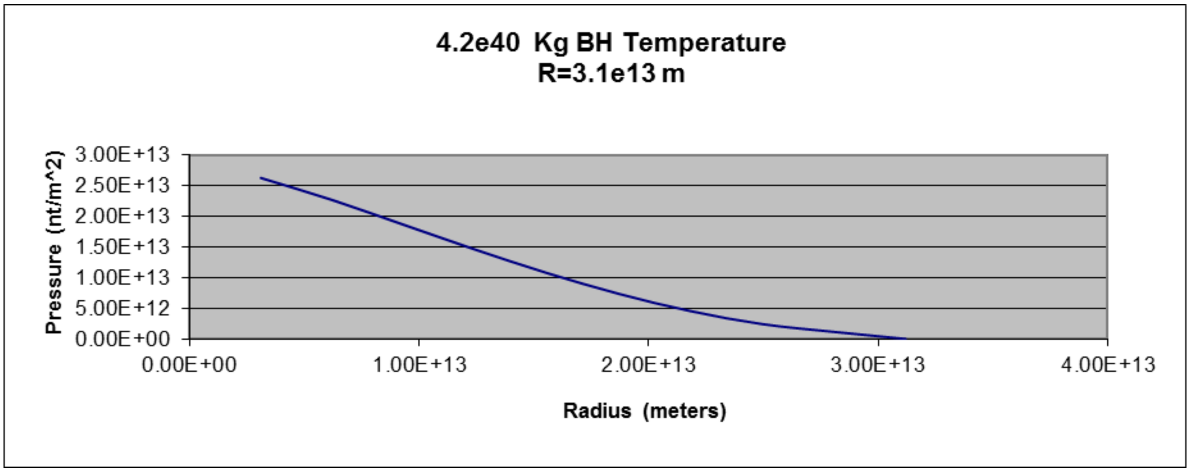
Stars that complete their aging cycle can be about 20 solar masses but not much greater according to Wiki. The analysis above was repeated for this size black hole.

P9 (nt/m^2)	P9=P8+rho8*a8*h0/10			7.47E+33	**7.42E+33**
rho9 kg/m^3	rho9=1.67E-27/(4/3*PI()*((((4.9e-25)/(P9)))^0.2565)^3)			2.39E+17	1.18524E-15
h9 (m)	h9=h8-h0/10			4.22E+04	1.01E+00
T (K)	T9=(9.7*7.34e-14/rcell)/1.5/8.6e-11			4.66E+12	4.66E+12
a9 (m/sec^2)	a9=C^2/h9			2.13E+12	9.55E-01
mass shell Kg	ms10=4/3*PI()*(h9^3-(h9-S/10)^3)*rho9			1.48E+31	
cum mass	cumm10=a9*h9^2/G			5.70E+31	5.98E-01
P10 (nt/m^2)	P10=P9+rho9*a9*h0/10			8.98E+33	**8.90E+33**
rho10 kg/m^3	rho10=1.67E-27/(4/3*PI()*((((4.9e-25)/(P10)))^0.2565)^3)			2.76E+17	1.13033E-15
h10 core	0			0	1.01E+00
r cell (m)	Cell radius	rcell=(1/rho10*1.67E-27/(4/3*PI()))^(1/3)		1.13E-15	4.88E+12
		C=(a*R19)^.5		3.00E+08	9.54E-01
				20x sol cmax	
		mass MeV		**9.38E+02**	mass MeV
		mass kg		**1.67E-27**	mass kg
		Field MeV		**2.68E+00**	Field MeV
Kinetic Energy		KE=9.7*7.34e-14/2.93e-16		**2002.32**	Kinetic Energy
gamma		g=m/(m+ke)		**3.19E-01**	gamma
		V/C		**9.48E-01**	V/C
Radius		R=rcell		**3.570E-16**	Radius
Force Nt		F=m*V^2/R/exp(90)		**9.71E-34**	Force Nt
				1.00E+00	
Cell surface area m^2		area=4*pi*R^2		**1.60E-30**	Cell surface area
Pressure nt/m^2		F*area*exp(90)		**7.40E+35**	Pressure nt/m^2

Supermassive Black Holes

Supermassive black holes are more similar to our sun than small mass black holes because their density is low. In fact, analysis shows that supermassive black holes have not burned out and their fusion kinetics are similar to the sun. The author is aware that there are short comings to applying the solar model to a black hole. Nevertheless, it is worth showing results even if the model is inaccurate because it reveals differences involved. First, we will apply the model to a BH of 4.2e40 Kg. Here is a plot of the pressure and temperature for a BH of 4.2e40 Kg with a horizon 3.1e13 meters. The average density of the BH is quite low, only 6e-2 Kg/m^3. Density and temperature vary together and when a different temperature profile is used, fusion kinetics remains about the same..





Here is the hydrogen fusion kinetics:

4.2e40 Kg Solar Model		
	Max Dens	5.020E+11
Temp	deg K	2.27E+13
Density	kg/m^3	4.73E+00
KE	1.5*B*T	2.93E+03
degeneracy		1.21E-01
Degenerate radius (DR)		5.290E-11
v/c		1.000
Barrier		-0.0139
P barrier		1.00E+00
Pdensity		9.42E-12
Rate/sec		7.903E-09
Probability/sec		7.45E-20
burn time (Byrs)		426
N=m/1.67e-27		5.988E+67
fract burning		0.15
burn rate N/sec*mev/N		6.69E+47
power mev/sec		4.47E+48

The 4.2e40 BH is burning so slowly that it could last 432 B years. Its heat generation can be compared to our sun (1e39 MeV/sec) but is 2.1e10 more massive. One difference from a star is that heat may not escape as readily. This would increase its overall temperature and lower its density. Density can't be lowered much or the mass will not fit within the Schwarzschild radius. The pressure profile depends on the mass and again can't change much. One might ask if the contained mass becomes a pressure cooker since nuclear energy cannot easily escape? According to the proton mass model, there is only 10 MeV/particle of nuclear energy available per particle. The effect of burning this fuel and containing it in the BH is shown below.

Nuclear energy release 10 MeV		
dQ=10 MeV		
dt=10/(1.5 B)		
7.73E+10	K	
T core=2e13K		
T core with dQ=2e13+7.8e10		
1.0078E+13	K	
P=7829 t d		
Pressure barely budges		

The analysis shows that the pressure is reasonably low and does not require much pressure to balance the bottom layer.

The BH surface

The surface of the black hole is the horizon. What are the conditions? As new protons enter the black hole and collide with the spherical surface they carry about 9.8 MeV of kinetic energy with them as a result of falling toward the black hole at high velocity. The gaseous sphere of the black hole receives incoming mass at about 7.6e10 K There is a lot of photon energy produced by a hot surface. One question might be: Where does the photon energy go? The Schwarzschild equation tells us that photons are attracted to the large gravitational pull of the BH and photons and travel in curved paths around the BH horizon. They travel at the speed of light but cannot escape. This means that at the horizon there is a large flux of photons. This flux probably photo-disintegrates bonds (electromagnetic and nuclear) of atoms that cross the horizon.

Summary

Black holes that range from 4.7 to 20 solar masses involve high core pressures. The author addressed the question “What keeps these black holes from collapsing?” Based on the author’s theory of quantum gravity the answer to this question is “gravity itself”. Thermodynamic pressure in low pressure gases is based on compression of the electron radius. The density in the gas adjusts in such a way to resist compression. When a radius is compressed beyond 4.6e-15 meters, the electron is overwhelmed since the kinetic energy involved converts a proton back into a neutron. Black holes involve radii as low as 2.93e-16 meters. The model for gravity resisting pressure is similar to thermodynamic pressure except the gravitational kinetic energy is 9.7 MeV, not the electromagnetic kinetic energy 13.6e-6 MeV.

Supermassive black holes as large as 4.2e40 Kg have been observed. These black holes involve temperature and pressures in their cores that strongly suggest nuclear energy generation. However, analysis shows that they burn very slowly and can contain the power generated.

Appendix Model Results

Central mass (Kg	2.00E+30	9.94E+30	4.20E+40	4.00E+31
	sun model	small cmax	largest cmax	20x sol cmax
Avg Density	1.44E+03	5.90E+18	3.31E-01	3.64E+17
total mass (addec	1.94E+30	9.96E+30	4.21E+40	4.01E+31
Black hole Radius	6.92E+08	7.38E+03	3.12E+13	2.97E+04
S' Schwarzschild	1.49E+03	7.38E+03	3.12E+13	2.97E+04
		9.80E+30	4.06E+40	3.13E+31
	sun model	small cmax	largest cmax	20x sol cmax
	6.000E+03	8.90E+12	1.00E+14	3.80E+12
	2.399E+06	7.90E+11	0.00E+00	7.2E+11
	2.400E+07	1.68E+13	8.00E-02	1.10E+13
		1.40E+19		4.70E+15
h0 (m)	6.92E+08	7.38E+03	3.12E+13	2.97E+04
T0 (K)	6.000E+03	9.000E+12	5.296E+06	1.04E+12
a (m/sec^2)	2.05E+02	1.22E+13	2.89E+03	3.03E+12
m1 (Kg)	5.27E+29	6.39E+30	2.76E+39	1.40E+29
cum mass1	5.266E+29	9.96E+30	4.21E+40	4.01E+31
P1 (Nt/m^2)	1.99E+13	1.26E+35	7.20E+14	4.23E+31
rho1 (kg/m^3)	1.400E+03	2.11E+18	8.00E-02	4.47E+15
h1	6.23E+08	6.64E+03	2.81E+13	2.67E+04
T	2.405E+06	9.61E+12	1.150E+12	1.24E+12
a	1.81E+02	1.35E+13	3.21E+03	3.37E+12
mass shell	4.22E+29	7.70E+29	4.21E+39	1.06E+29
cum mass2	9.483E+29	8.96E+30	3.79E+40	3.61E+31
P2	3.74E+13	1.47E+35	1.52E+15	8.70E+31
rhonew	8.345E+03	2.37E+18	1.53E-01	7.79E+15
h2	5.54E+08	5.91E+03	2.50E+13	2.38E+04
T	4.805E+06	1.00E+13	2.422E+12	1.49E+12
a	1.57E+02	1.52E+13	3.61E+03	3.79E+12
mass shell	3.28E+29	6.76E+29	4.21E+39	1.44E+29
cum mass	1.277E+30	7.97E+30	3.37E+40	3.21E+31
P	1.28E+14	1.74E+35	3.24E+15	1.75E+32
rhonew	1.433E+04	2.70E+18	1.96E-01	1.33E+16
h3	4.84E+08	5.17E+03	2.18E+13	2.08E+04
T	7.204E+06	1.04E+13	4.532E+12	1.78E+12
a	1.36E+02	1.74E+13	4.12E+03	4.33E+12
mass shell	2.47E+29	5.77E+29	4.21E+39	1.86E+29
cum mass	1.524E+30	6.97E+30	2.95E+40	2.81E+31
P	2.63E+14	2.08E+35	5.76E+15	3.46E+32
rhonew	1.957E+04	3.10E+18	2.61E-01	2.25E+16
h4	4.15E+08	4.43E+03	1.87E+13	1.78E+04
T	9.604E+06	1.09E+13	7.351E+12	2.12E+12
a	1.16E+02	2.03E+13	4.81E+03	5.05E+12
mass shell	1.77E+29	4.76E+29	4.21E+39	2.25E+29
cum mass	1.700E+30	5.98E+30	2.53E+40	2.40E+31
P	4.20E+14	2.55E+35	9.67E+15	6.83E+32
rhonew	2.345E+04	3.62E+18	3.64E-01	3.80E+16
h5	3.46E+08	3.69E+03	1.56E+13	1.49E+04
T	1.200E+07	1.15E+13	1.074E+13	2.52E+12
a	1.01E+02	2.44E+13	5.77E+03	6.06E+12
mass shell	1.19E+29	3.72E+29	4.21E+39	2.55E+29
cum mass	1.819E+30	4.98E+30	2.10E+40	2.00E+31
P	5.84E+14	3.20E+35	1.62E+16	1.37E+33
rhonew	2.608E+04	4.32E+18	5.43E-01	6.49E+16
h6	2.77E+08	2.95E+03	1.25E+13	1.19E+04
T	1.440E+07	1.22E+13	1.456E+13	3.01E+12
a	9.51E+01	3.05E+13	7.21E+03	7.57E+12
mass shell	7.19E+28	2.69E+29	4.21E+39	2.64E+29
cum mass	1.891E+30	3.98E+30	1.68E+40	1.60E+31
P	7.55E+14	4.17E+35	2.84E+16	2.83E+33
rhonew	2.813E+04	5.30E+18	8.95E-01	1.13E+17
h7	2.08E+08	2.21E+03	9.36E+12	8.91E+03
T	1.680E+07	1.31E+13	1.862E+13	3.63E+12
a	1.12E+02	4.06E+13	9.62E+03	1.01E+13
mass shell	3.69E+28	1.70E+29	4.21E+39	2.37E+29
cum mass	1.928E+30	2.99E+30	1.26E+40	1.20E+31
P	9.73E+14	5.76E+35	5.53E+16	6.23E+33
rhonew	3.107E+04	6.79E+18	1.74E+00	2.08E+17
h8	1.38E+08	1.48E+03	6.24E+12	4.52E+04
T	1.920E+07	1.42E+13	2.267E+13	4.45E+12
a	2.04E+02	6.10E+13	1.44E+04	1.99E+12
mass shell	1.36E+28	8.00E+28	4.21E+39	1.49E+31
cum mass	1.941E+30	1.99E+30	8.42E+39	6.10E+31
P9 (nt/m^2)	1.41E+15	8.82E+35	1.34E+17	7.47E+33
rho9 kg/m^3	3.946E+04	9.42E+18	4.73E+00	2.39E+17
h9 (m)	6.92E+07	7.38E+02	3.12E+12	4.22E+04
T (K)	2.160E+07	1.58E+13	2.628E+13	4.66E+12
a9 (m/sec^2)	7.90E+02	1.22E+14	2.89E+04	2.13E+12
mass shell Kg	1.94E+27	1.59E+28	4.21E+39	1.48E+31
cum mass	1.943E+30	9.96E+29	4.21E+39	5.70E+31
P10 (nt/m^2)	3.57E+15	1.73E+36	5.59E+17	8.98E+33
rho10 kg/m^3	8.869E+04	1.58E+19	3.31E+01	2.76E+17
h10 core	0	0	0	0
r cell (m)	1.65038E-11	2.93E-16	2.29E-10	1.13E-15
		3.00E+08	3.00E+08	3.00E+08

Appendix 2 Fusion Kinetics

Solar example			B=8.62e-11		
Temp	deg K		2.39E+07	Dmax kg/m^3	
Density	kg/m^3		1.22E+05	5.020E+11	
KE temp	1.5*B*T		3.084E-03		
degeneracy			3.56E+00		
Degenerate radius (DR)			1.485E-11		
v/c			0.109		
Barrier			-0.0139		
Example calculation for above conditions					
rate		Pbarrier		Pd=(dens/max)	Preaction rate F
Probability/sec		exp(-.0139/.005		(1.2e5/5e11)^2	v/r/exp(62.87)
8.19E-18			1.09E-02	2.43E-07	1.097E-09
burn time (Byrs)			3.9		3.078E-09
sun N			1.198E+57		
fract burning			0.15		
burn rate N/sec*mev/N			1.47E+39		
power mev/sec			9.82E+39		

Source Reference 9.

Appendix 3

Development of equation for rho from pressure for a black hole

gamma	3.19E-01	gamma (g)=938.2/(938.2+9.72*7.34e-14/EQ481)			
P (nt/m^2)	7.39E+35	Pressure=((1.67e-27/(g))*(((1-(g)^2)^0.5)*C)^2/r)/(4*PI()*r^2)			
T (K)	1.55E+13	T=(9.7*7.34e-14/EQ481)/1.5/8.6e-11			
rho (kg/m^3)	8.76E+18	rho=1/r^3*1.67E-27/(4/3*PI())			
R gas constai	5.46E+03	R=P/(rho*T)			
rcell	3.57E-16	3.57E-16			

Pressure, temperature and rho are all fixed once the radius of the cell is known. The equations below give the radius as a function of pressure. Since r is “buried” in the equations above, an approximate solution was developed and is shown below. Once r was written explicitly, rho was determined from the radius.

		P*r^3	P*r^3 with r=1	k=pr^3/r^0.988	
				1.86e-11/3.57e-16^0.988	
r^3	4.55E-47	4.55E-47			
gamma	3.19E-01	3.19E-01			
P	**7.39E+35**	**3.36E-11**	**1.86E-26**	3.40E-11	
T	1.55E+13	1.55E+13			
rho	8.76E+18	8.76E+18			
R	5.46E+03	5.46E+03			
		3.57E-16			
	3.57E-16	3.57E-16		3.57E-16	
k=1.86e-26/3.57e-16^0.988		p=k/r^3			
Development of equation for rho					
3.58E-16					
3.58E-16					
3.58E-16					
r=(k/P)^.33					
3.57e-16=1.86e-26^(1/3)/(3.57e-16^0.988)^(1/3)/(7.39E+35)^(1/3)					
r*(r^.988)^.33		(k/P)^.333*(r^.988)^.33			
(3.57e-16)*(3.57e-16^.988)^(1/3)=1.86e-26^(1/3)/(7.39E+35)^(1/3)					
2.92E-21		2.93E-21			
2.92E-21		2.93E-21			
2.92E-21					
(3.57e-16^(3.988/3))		(((1.86E-26)/(7.39E+35))^(1/3))^(3/3.988)			
		3/(3*3.988)	0.2508		
r					
3.57E-16		3.58E-16			
Density equation					
rho=kg/m^3=1.67e-27/(4/3*pi()*r^3)					
rho=1.67E-27/(4/3*PI()*((4.8E-25/P)^0.2565)^3)					
	4.80E-25				
P	7.39E+35				
rho	8.22E+18				

The above rho equation is within 8% of actual rho over the BH pressure range.

Appendix 4

Review of Cellular cosmology

Using a small cells of radius r to simulate a large radius R (literature would call this the radius of the universe) is critical to understanding cosmology. In this model [5], the universe is filled with the *surface* of many small cells that are equivalent to the *surface* of one large sphere. This is important conceptually because we can be inside the universe (something we all observe), each surface can be identical and the concept that there is no preferred location can be preserved. The model proposed is based on exp(180) cells, each associated with a proton like mass.

The derivation of a coupling constant for gravitation from reference 6 is reviewed below: Let small r represent the radius of a many small spheres and large R represent the same surface area of one large sphere containing exp(180) spheres. There is one proton like mass (m) on the surface of each cell. The mass of the universe M equals m*exp(180). The laws describing each particle are no different than any other particle. Geometrically, many small cells with the same combined surface area offer this feature. General relativity uses the metric tensor (ds^2)[4]. The surface area of a 2-sphere is broken into many small spheres with an equal surface area, i.e. A=a*exp(180) and r=R/exp(90). The total energy will be that of a proton mass/cell plus a small amount of expansion kinetic energy. Based on geometry, two substitutions are placed in the gravitational constant G below, i.e. M=m*exp(180) and R=r*exp(90).

	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)			
Large space G		cellular size G		
RV^2/M	G=G	rv^2/m	r is the cell radius	
R'V^2/M	G=G	r'v^2/m	r' is the proton size geodesic	
R'=r*('v/V)^2*(M/m)*1/exp(90)				
	RV^2/M=	r*exp(90) *v^2/(m*exp(180))		
		G=(r *v^2/m)*1/exp(90)		

For G to be equivalent between many small cells and one large sphere the geodesics (the combination of r,v and m that give G) of cells must be multiplied by the small factor 1/exp(90). This value is the gravitational coupling constant [6] for a cell that has cosmological properties, i.e. the force is shared with exp(180) particles on a surface that is 1/exp(90) of the total surface. The author documented a quantum theory of gravity [6]. The quantum scale was identified as radius 7.34e-14 meters.

The Proton mass model [6] is repeated below for convenience:

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

The important values used for gravity are field energy 2.683 MeV and expansion kinetic energy 20.3 MeV. Note the value 0.111 MeV required to convert a proton back to a neutron.

References

1. Brillouin, L., *Science and Information Theory*, New York: Academic Press, Inc., 1956.
2. Shannon, Claude. A mathematical Theory of Communication, 1948.
3. P.J.E. Peebles, *Principles of Physical Cosmology*, Princeton University Press, 1993.
4. Bennett, C.L. et al. *First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Data*, Astrophysical Journal, 2001 L. Verde, H. V. Perris, D. N. Spergel, M. R. Nolta, C. L. Bennett, M. Halpern, G. Hinshaw, N. Jarosik, A. Kogut, M. Limon, S. S. Meyer, L. Page, G. S. Tucker, E. Wollack, E. L. Wright
5. Barbee, Gene H., *A Top-Down Approach to Fundamental Interactions*, FQXi essay, June 2012 and vixra:1307.0082 revised Mar 2014. Reference Microsoft ® spreadsheet Unifying concepts of nature.xls.
6. Barbee, Gene H., *On the Source of the Gravitational Constant at the Low Energy Scale*, vixra:1307.0085, revised Feb 2014. Prespacetime Journal Vol. 5 No. 3 March 2014.
7. Barbee, Gene H., *Application of Proton Mass Model to Cosmology*, vixra:1307.0090, revised Mar 2014. Reference spreadsheet simple1c.xls.
8. Barbee, Gene H., *On Expansion Energy, Dark Energy and Missing Mass*, Prespacetime Journal Vol. 5 No. 5, May 2014. Previously vixra:1307.0089, revised Mar 2014.
9. Barbee, Gene H., *Semi-Fundamental Abundance of the Elements*, vixra:1308.0009, revised Nov 2013.
10. Bergstom, L. and Goobar, A., *Cosmology and Particle Astrophysics*, 2nd Edition, Springer-Praxis Books in Astrophysics and Astronomy, 2004.

11. Barbee, Gene H., *The Effect of He4 Fusion on Primordial Deuterium*, vixra:1404.0465, May 2014.
12. Barbee, Gene H., *The Language of Nature*, Amazon books, May 2014.
13. Barbee, Gene H., *Cosmology, Thermodynamics and Time*, vixra:1407.0187, September 2014.
14. Barbee, Gene H., *A Fundamental Model of Atomic Binding Energy*, vixra:1307.0102, accompanying Microsoft ® spreadsheet atom.xls.
15. http://en.wikipedia.org/wiki/Black_hole