Baryon decay times and mass simulations

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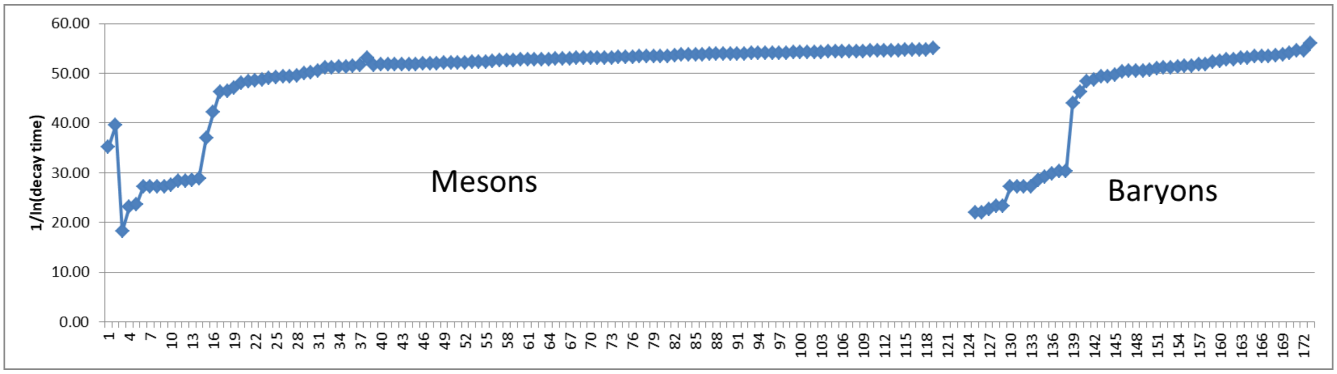
Abstract:

Part 1: Baryon and meson decay
High energy labs produce baryons and mesons and measure their masses. They study their decays and classify them according to their properties. The Particle Data Group consolidates data and reviews models. The author downloaded 2020 information [7][8] from the website and analyzed it. The latest PDG review indicates that mass models lack accuracy due to resonances within the particles. The author developed a model of the proton and neutron [5][6] and used it to study whether it could help predict mass and decay times for the 103 baryons listed by PDG. This paper proposes that baryon quark bundles orbit a negative energy similar to but not exactly the same as neutrons and protons. For baryons and mesons the negative energy is the Breit-Wigner width. The quark bundles orbit for only one revolution before decaying.

This work started as an attempt to understand why decay times for mesons and baryons varies over about 19 orders of magnitude. I reasoned that there must be an underlying correlation with properties of the particles. Decay rates are measured by gathering information and analyzing it with the Breit-Wigner probability equation [Wiki]. The width is the energy across decay distributions at probability 0.5 and published in Particle Data Group data sheets. The decay time is hbar/width with energy in MeV and decay time in seconds.. It is proposed that the baryon Breit-Wigner width energy is related to energy resonances but becomes negative as the particle takes a form similar to the proton. Insight into decay was gained by comparing models of the decaying particles with a model of the proton that does not decay. This works both ways since the proton model was improved by the effort.

Part 2: Baryon mass correlations
Another goal of this document was to correlate the masses of the baryons. Correlating the massive amount of data available is a huge task and does not yield easily to correlation. The Particle Data Group publishes reviews but indicates that "resonances" are encountered that hinder the accuracy of meson and baryon mass models (current accuracy about 30%). Improving this accuracy is important to particle physics. It was found that the mass model of the proton and neutron produces a series of resonances useful for simulating the mass of these particles.

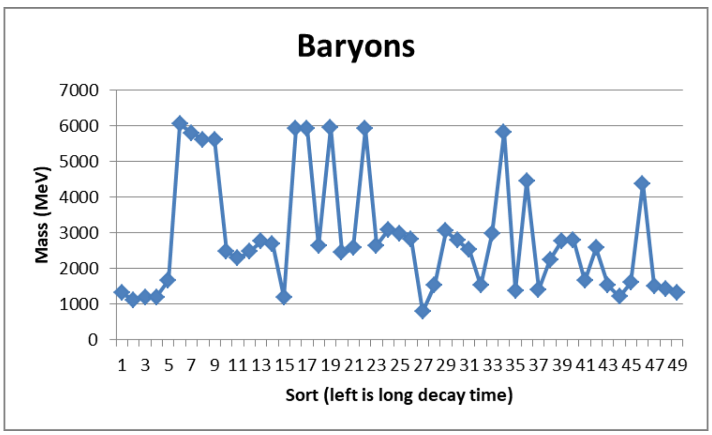
Background for Part 1: Decay times
The PDG decay time data was entered into an Excel ® spread sheet. The decay times vary from 2e-6 seconds to 1e-25 seconds (19 orders of magnitude). This is a huge range for particle that range from 105 MeV to 10400 MeV. The following graph is produces by sorting the mesons and baryons from long life to short life (on the right below). The y axis = ln(1/decay time in seconds), where ln stands for natural logarithm.



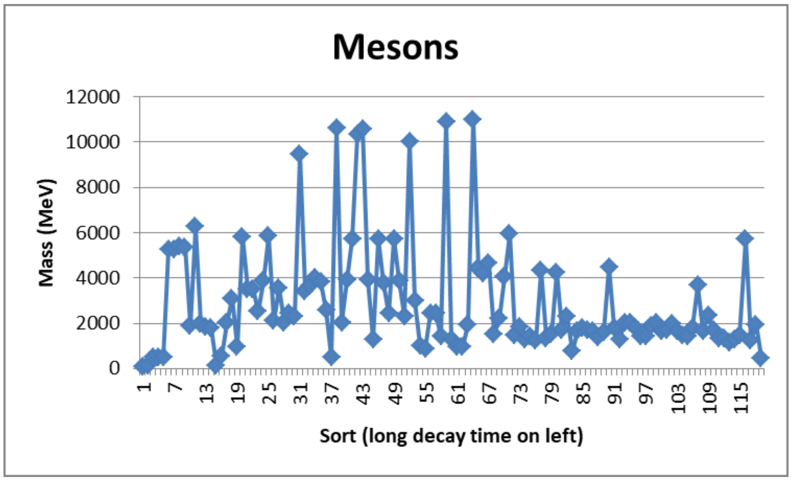
Example: natural log of particle with 1277 MeV mass has decay time 2.9e-10 seconds. Natural log(1/2.9e-10)= 21.96 if the numerator is 1 second.

Baryon and meson mass variability

The following graph is the mass associated with the sorted decay times. Measured baryon mass is shown on the y axis. Message: long lives on the left are not necessarily low mass particles and there is a lot of variability.



The mesons mass variability is shown below; the same message, long life particles on the left are not necessarily low mass particles.



Breit-Wigner width fundamentals

Two of the baryons, the proton and neutron, have radii that follow the simple formula below. The value 20.3 MeV is the called weak energy (also called residual strong energy). This value originates in the mass model of the proton discussed below.

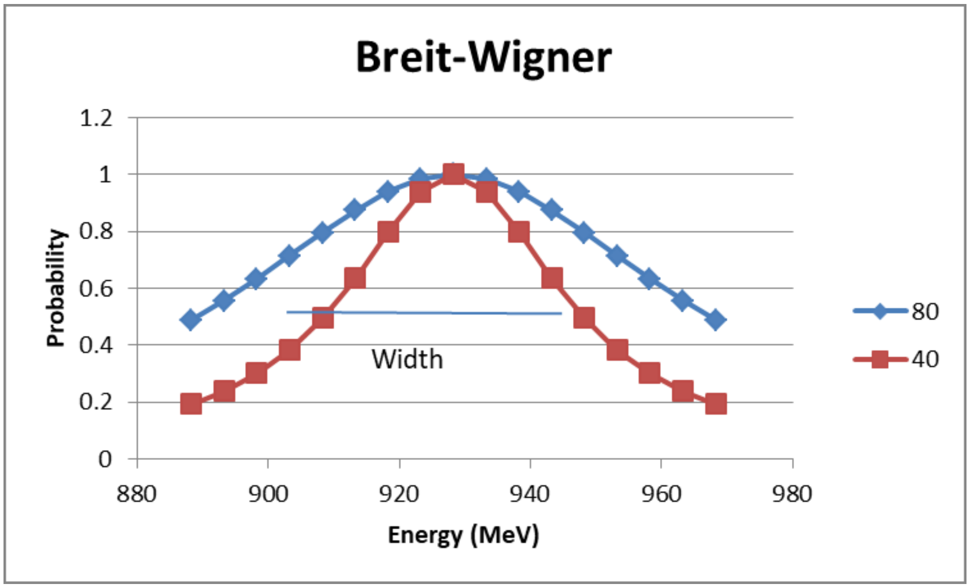
R=hC/(mass*20.3)=1.97e-13 MeV-m/(938.27*20.3)^0.5= 1.43e-15 meters (proton)

The 3 quarks form a "bundle" (called a bag in the MIT bag model of meson and baryons). The quark bundle inside mesons contains two quarks and quark kinetic energy. For baryons, the same is true for three quarks. The bundle in the equation above is 928.12 MeV, and orbits with 10.15 MeV of weak kinetic energy. The velocity of the bundle around the radius is given by the relativistic formula v=C*(1-(928.12/(928.12+10.15))^0.5= 0.147. Since 10.15 is one half 20.3 MeV, a stable orbit is established with forces balances.

The time to circle the radius is:

Circle time= 2*pi()*1.43e-15/(0.147*3e8)= 3.25e-21 seconds.

The Breit-Wigner equation correlates decay energy data for a single meson or baryon. It yields a full width measurement at probability 0.5 in the plots below. The narrower peak is associated with a lower width (40 MeV in the example below).



Energy	Mass	Width		P=(1/((Energy^2-Mass^2)^2+Width^2*Mass^2))			
5		40		Ln(P)	Ln(P)/Ln(P')		
928.27	928.27	40		-21.0444042	1	1	
933.27	928.27	40		-21.105346	0.940877957	0.984534	
938.27	928.27	40		-21.2697058	0.798275447	0.940579	
943.27	928.27	40		-21.4965151	0.636283612	0.874962	
948.27	928.27	40		-21.7483239	0.494642647	0.796549	
953.27	928.27	40		-22.0017848	0.383897158	0.713666	
958.27	928.27	40		-22.2453635	0.300905416	0.632581	
963.27	928.27	40		-22.4744902	0.23928834	0.557176	
968.27	928.27	40		-22.6880929	0.193265827	0.489343	

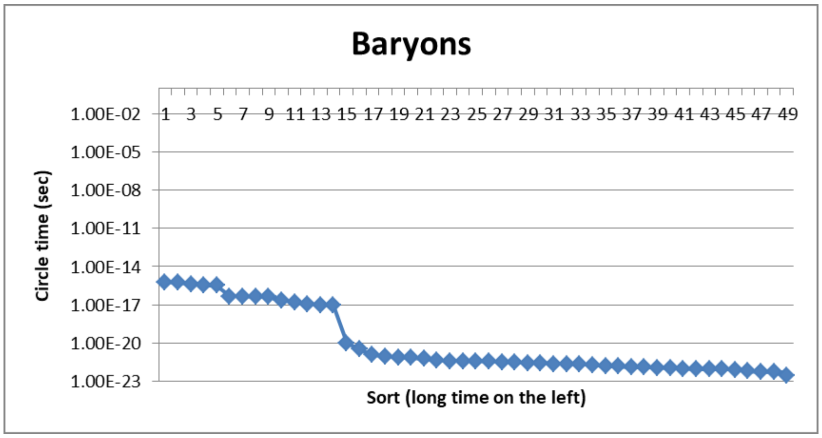
This can be simplified to only produce the probability ratio 0.5 if the width/2 is added to the proton mass.

			40		Ln(P)	Ln(P)/Ln(P')		
	928.27	928.27	40		-21.0444042	1	1	
20	948.27	928.27	40		-21.7483239	0.494642647	1	

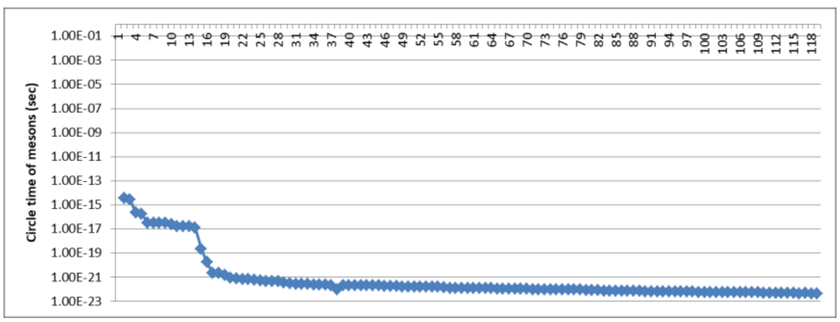
According to the Breit-Wigner equation, the 40 MeV width destabilizes the wave function and decay rate is proportional to the width energy. If the width above was the weak field energy 20.3 MeV, the proton of mass 938.27 MeV would be stable. Other baryons have different width energy and are not stable.

Circle time of the barons

There are many energy values (mass of the quarks and resonances of kinetic energy) that make up the quark bundle. What makes the width the special energy that causes decay? The same sort (decay time long to short) is used in the plot below but this time the half width determines V for the circle time around R for the baryon. The Y axis below is circle time.



The mesons produce a similar plot shown below:



Decay time and circle time relationship

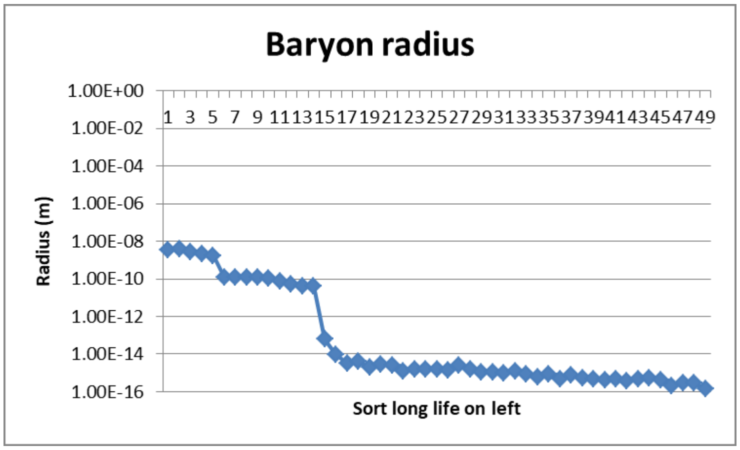
Calculations were carried out similar to the proton above. A radius was determined and the time to circle the radius was determined. Width was used as the field and V/C was determined from half width. The circle time was always decay time multiplied by 2pi.

R=1.973e-13/(M*width)^.5

And V/C= (1-((M-half width)/M)^2)^.5

Circle time=2 pi R/(VC). Circle time= 2 pi * measured decay time.

The high energy experiments produce small radius baryons as follows (again the same sort, long decay time to short decay time on the right).



The time to circle radius R was always the decay time multiplied by 2 pi.

This requires some understanding. The accelerator is producing a great deal of kinetic energy. It is energizing resonances in nature that form a bundle (bag) of quarks that circles the negative energy. An accelerator produces kinetic energy but where does the negative value in the equation R=1.97e-13/(M*negative value)^.5 originate? The negative value is probably not resonances since they would be various constants. Nor would the negative value be a field since all the accelerator can produce is kinetic energy. Example calculations are below for a few baryons downloaded from the PDG website. The decay time convention is h/width but if it were H/width instead circle time would be decay time.

Decay KE		Particle	PDG Mass	R=1.973e-13/(M*width)^.5			(seconds)
(MeV)		Name	(MeV)	(meters)		Circle Time	H/width
	1	p			V/C=(1-((M)/(M+ke))^2)^0.5		
	2	n				time=2*pi()*R,	decay time
175.0	3	N (1440) 1,	1440.00	2.8E-16	4.8E-01	1.2E-23	1.2E-23
55.0	4	N (1520) 3,	1515.00	4.8E-16	2.7E-01	3.8E-23	3.8E-23
75.0	5	N (1535) 1,	1530.00	4.1E-16	3.1E-01	2.8E-23	2.8E-23
62.5	6	N (1650) 1,	1652.50	4.3E-16	2.7E-01	3.3E-23	3.3E-23
72.5	7	N (1675) 5,	1672.50	4.0E-16	2.9E-01	2.9E-23	2.9E-23
61.3	8	N (1680) 5,	1685.00	4.3E-16	2.7E-01	3.4E-23	3.4E-23
100.0	9	N (1700) 3,	1725.00	3.4E-16	3.4E-01	2.1E-23	2.1E-23
70.0	10	N (1710) 1,	1710.00	4.0E-16	2.8E-01	3.0E-23	3.0E-23
137.5	11	N (1720) 3,	1715.00	2.9E-16	3.9E-01	1.5E-23	1.5E-23
92.5	12	N (1875) 3,	1885.00	3.3E-16	3.1E-01	2.3E-23	2.2E-23
150.0	13	N (1880) 1,	1880.00	2.6E-16	3.9E-01	1.4E-23	1.4E-23
70.0	14	N (1895) 1,	1895.00	3.8E-16	2.7E-01	3.0E-23	3.0E-23
105.0	15	N (1900) 3,	1920.00	3.1E-16	3.3E-01	2.0E-23	2.0E-23
187.5	16	N (2060) 5,	2115.00	2.2E-16	4.1E-01	1.1E-23	1.1E-23
130.0	17	N (2100) 1,	2100.00	2.7E-16	3.5E-01	1.6E-23	1.6E-23
155.0	18	N (2120) 3,	2105	2.44242E-16	0.377	1.4E-23	1.3E-23
200.0	19	N (2190) 7,	2170	2.11771E-16	0.419	1.1E-23	1.0E-23
212.5	20	N (2220) 9,	2250	2.01763E-16	0.424	1.0E-23	9.7E-24
225.0	21	N (2250) 9,	2285	1.94571E-16	0.433	9.4E-24	9.2E-24
325.0	22	N (2600) 1	2650	1.50331E-16	0.480	6.6E-24	6.4E-24
58.5	23	Δ(1232) 3/	1232	5.19671E-16	0.304	3.6E-23	3.5E-23
58.5	23	Δ(1232) 3/	1232	5.19671E-16	0.304	3.6E-23	3.5E-23
58.5	23	Δ(1232) 3/	1232	5.19671E-16	0.304	3.6E-23	3.5E-23
58.5	23	Δ(1232) 3/	1232	5.19671E-16	0.304	3.6E-23	3.5E-23
125.0	24	Δ(1600) 3/	1510	3.21121E-16	0.398	1.7E-23	1.7E-23
65.0	25	Δ(1620) 1/	1610	4.31263E-16	0.281	3.2E-23	3.2E-23
150.0	26	Δ(1700) 3/	1710	2.75466E-16	0.410	1.4E-23	1.4E-23
125.0	27	Δ(1900) 1/	1880	2.87792E-16	0.359	1.7E-23	1.7E-23
167.5	28	Δ(1905) 5/	1882.5	2.48449E-16	0.412	1.3E-23	1.2E-23
150.0	29	Δ(1910) 1/	1900	2.6133E-16	0.389	1.4E-23	1.4E-23
150.0	30	Δ(1920) 3/	1920	2.59966E-16	0.387	1.4E-23	1.4E-23
150.0	31	Δ(1930) 5/	1950	2.57958E-16	0.385	1.4E-23	1.4E-23
142.5	32	Δ(1950) 7/	1932.5	2.65855E-16	0.377	1.5E-23	1.5E-23
175.0	33	Δ(2200) 7/	2200	2.24844E-16	0.391	1.2E-23	1.2E-23
250.0	34	Δ(2420) 11	2450	1.78262E-16	0.440	8.5E-24	8.3E-24
0.0	35	Λ	1115.683	3.73522E-09	0.000	1.7E-09	1.7E-09
25.3	36	Λ(1405) 1/	1405.1	7.40675E-16	0.189	8.2E-23	8.2E-23
8.0	37	Λ(1520) 3/	1519	1.26558E-15	0.102	2.6E-22	2.6E-22
100.0	38	Λ(1600) 1/	1600	3.4878E-16	0.348	2.1E-23	2.1E-23
15.0	39	Λ(1670) 1/	1674	8.80418E-16	0.134	1.4E-22	1.4E-22
35.0	40	Λ(1690) 3/	1690	5.73634E-16	0.202	5.9E-23	5.9E-23

The fundamental proton and neutron models

The proton model can help understand how the proton produces its 20.3 MeV weak field energy**.** Proof that this value is accurate is found in references 2 and 3. Its origin is found in reference 1 and used extensively in reference 4, 5 and 6. One goal of this study was to understand why the other baryons do not use 20.3 MeV of weak energy for width energy. Finding where width energy originates became a goal. There are two models below; the model on the left is the proton. The left columns of the proton model show mass and kinetic energy values that add to the value 938.27 MeV (to within 5 significant digits). The model also shows energy outside the proton useful for cosmological theories [4]. The right two columns of the proton model contains it quark field energy values. Overall the bottom of the diagram indicates that total mass and kinetic energy is equal and opposite total field energy.

Toward the center of the models values called N are listed. Energy is related to N by the following 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			
	0.00			
	0.00			
Neutrino ke	-0.67		10.50694	0.74
ae neutrino	-2E-05			
E/M field	-2.7E-05			
938.27				
	2.72E-05	0.296		
	-0.6224	-10.33		
0.51100024	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	

Quark mas	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 Voic	-20.30			
	0.00			
	0.00			
	0.62		10.51	0.74
939.5654				
	-0.62			
	0.74	10.51		
expansion	10.15			
expansion	10.15			
959.99				959.99
Total N values		90.10	90.10	

The 5.08 MeV values (20.3/4) are kinetic energy and required to balance the top three blocks to zero energy and probability 1. But the mass and kinetic energy values that total 938.27 MeV contain negative energy -20.3 MeV. The three top blocks of the model produce the energy but 20.3 MeV is borrowed, making it negative energy. It is called a weak field but also called residual strong energy in the literature. As the orbit form, the bundle of quarks falls into the field. When its kinetic energy equals 10.15 MeV, a stable orbit is formed. This block of the model would now be represented by:

Weak Void	-20.30			
Weak KE	10.15			
Balance	-10.15			
Neutrino ke	-0.67		10.50694	0.74
ae neutrino	-2E-05			
E/M field	-2.7E-05			
938.27				

With Weak KE= 10.15 MeV. Now the masses and kinetic energy values add to the proton mass 938.27 MeV if a balancing entry -10.15 MeV exists in the table. The value -20.3 MeV acts more like a whirlpool might act. Perhaps the mass and kinetic energy circle a void. If the whirlpool stops, the original values are recovered. This is a rough analogy but real gluon related fields in the model are equal and opposite mass plus kinetic energy. The value 20.3 MeV is different.

I believe the model represents the proton including space and time and that nature is a manifestation of the proton. Values outside the proton must be included. The 20.3 MeV value is in the bottom (space part of the model). The entire right hand side energy must equal the entire left hand side and the right hand side adds up to 959.99 MeV. The energy outside the proton must be 959.99-proton mass (shown below).

938.27				
	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 -20.3 MeV inside the proton is part of its relationship to everything else. The proton has expansion plus potential energy equal to 20.3 MeV. During expansion, kinetic energy is converted to potential energy but the total is maintained.

Why is the proton stable?

Nature is very good at producing stable protons. The Breit-Wigner equation indicates that width energy destabilizes the wave function. Width becomes the decay rate for baryons but not protons. To understand proton stability we need to understand its wave function.

Probability values in the proton model underlie its wave function.

For each set of values, P=1 satisfies the Schrodinger equation:

			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

The probabilities are p=1/exp(N), where N is N=ln(E/2.02e-5). For example;

P=1/exp(15.43)*1/exp(12.43)/(1/exp(17.43)*1/exp(10.43))=1. This means when we write:

15.43+12.43=17.43+10.43, we are specifying N values that represent P=1.

Overall the 4 sets multiply 1*1*1*1=P=1. This is the wave function for the top part of the proton model.

The bottom part of the diagram has a set of probabilities highlighted below:

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				
	2.72E-05	0.296		
	-0.6224	-10.33		
0.5110	0.11	10.14		
electron neut	2.02E-05			
Neutrino ke	0.67	10.41		
	0.74			
expansion pe	10.15			
expansion ke	10.15			

0.296-10.33-10.14+10.41=10.5069. Again these probabilities multiply to 1.0.

I believe the proton is stable because the five sets of probabilities=1. Why does circle time= decay time *2pi= one time around the circle? Perhaps because the wave functions for other baryons do not multiply to probability 1.0. Collapse of Schrodinger type wave functions occur every probability 1. The particle “discovers” at this point that the wave function is incomplete. Decay then ensues at the decay rate (width).

Part 2: Baryon mass simulations

Proton mass model with PDG value quarks

Putting further discussion regarding width energy aside for the moment, many readers will recognize that the top blocks of the proton model don’t agree with Particle Data Group quark mass measurements. Details are below but the result is proton and neutron model consistent with all PDG data. The goal of this effort is to use the best data from PDG to understand the meson and baryon measured masses. The following table lists masses for the quarks of interest and some properties discussed later.

Particle Data Group at Berkeley (		2008	(I J)		**2012**	**2014**	**2016**	
Particle Data Group designation		pdg mass (mev)	properti	charge	PDG	PDG		
pdg quarks	up	1.5-3.3	.5 .5+	0.667	**2.4**	**2.3**	**2.2**	**0.289629**
pdg quarks	down	3.5-6	.5 .5+	-0.333	**4.9**	**4.8**	**4.7**	**-0.34315**
pdg quarks	strange -1	104 +26/-34	0 .5+	-0.333	**100**	**95**		
pdg quarks	charm +1	1250+/-90	0 .5+	0.667	**1290**	**1275**		
pdg quarks	bottom=-1	4200 +170/-7	0 .5+	-0.333	**4190**	**4180**		
new bottom						**4660**		

Data from various sources was correlated using the equation E=2.02e-5*exp(N). A pattern of N values appeared to define the energy of quarks and bosons. (The value 2.02e-5 MeV is evaluated with the known mass of the electron and the value N for the electron. Its value is 10+1/3-2*ln(3)-1=10.136. The calculation then is 0.511/exp(10.136)=2.02e-5).

unifying concepts.xls cell aw48			
		Selected E in	**Energy of**
		Particle Data	N series
Identifier	Ni or N	Group range	**(Mev)**
		(Mev)	**E=2.02e-5*exp(N)**
1/3 of E/M E	0.0986		
e neutrino ke	0.197	2.00E-06	
E/M Field E	0.296	0.0000272	
	(3*.0986=.296)		
ELECTRON	10.136	0.51099891	0.51099891
mu neutrino	10.408	0.19	
Graviton*		1.75E-26	
Up Quark M	11.432	2.490	1.87
E Operator	12.432		5.08
Down Quark	13.432	4.357	13.797
Strange Quar	15.432	102	101.95
Charmed Fiel	17.432	1282	753.29
Bottom	19.432	4175	5566.11
Quark?	21.432		
W+,w- boson	22.106	80399	
Z	22.228	91188	
HIGGS	22.575	125300	

Note the series N=13.43, 15.43, 17.43 & 19.43.

Based on the PDG values for the up and down quarks, these particles should have an N value of 13.43 (13+1/3+ln(3)-1). The related energy would be 13.79 MeV but the PDG data showed values consistent with 2.49 and 4.36 MeV respectively. These values are multiples of the energy 0.622 MeV (N=10.333). It appears that the PDG up and down quarks have transitioned to a lower energy state while conserving kinetic energy. The conserved energy is shown below. We will explore whether other quarks have transitioned to lower states.

2.49=13.8-11.307

4.36=13.8-9.44

The proton model is shown below with quark masses consistent with PDG data. Overall mass of the proton is maintained as kinetic energy is conserved.

	Quark mass	Kinetic E			Field E			Quark mas	Kinetic E			Field E
	(MeV)	(Mev)			(MeV)			(MeV)	(Mev)			(MeV)
DOWN	4.36	651.34			753.29		DOWN	4.36	651.34			753.29
-0.333		88.15					0.333		88.15			
		9.44							9.44			
		0.69			0.69				0.69			0.69
UP	2.49	88.15			101.95		DOWN	4.36	88.15			101.95
0.667		11.31					0.333		9.44			
		0.69			**0.69**				**0.69**			0.69
UP	2.49	88.15			101.95			2.49	88.15			101.95
0.667		11.31					-0.667		11.31			
		0.69			0.69				0.69			0.69
	Weak Void	-20.30						Weak Voic	-20.30			
		0.00							0.00			
		0.00							0.00			
	Neutrino ke	-0.67			0.74				0.62			0.74
	ae neutrino	-2E-05										
	E/M field	-2.72E-05										
charge 1	938.2721						charge 0	939.5654				
electron	0.51	2.72E-05							-0.6224			
	electron ke	0.11										
		-0.6224										
	electron neu	2.02E-05										
	Neutrino ke	0.67							0.74			
		0.74										
	expansion pe	10.15						expansion	10.15			
	expansion ke	10.15						expansion	10.15			
	959.99				959.99			959.99				959.99

The energy values will be used below to model baryon masses.

The above information was used in an attempt to understand the PDG quark masses. The fact that meson decay products are combinations of lower energy quarks and kinetic energy supports the theory that quarks and resonance combinations might simulate the measured masses of all the mesons and baryons. Our goal below is to understand the combination rules and resonances.

The following rules will be applied:

1. Simulated mass= total quark mass+ resonances total- width energy. This rule was derived by observing that negative 20.3 is required to simulate proton mass. The negative width in the baryon mass sum is the same value in R=hC/(m*width)^.5. This means the accelerator must provide extra energy because it is taken out of the total mass.
2. The quark assignments are consistent with the PDG data. This means that the quark assignments yield the PDG data for iso-spin, spin, charge and angular momentum.
3. Two quarks for mesons and three for baryons.
4. Neutron and proton simulations must use the same resonances. Baryon resonances may be multiples of the base resonance.
5. The resonances must provide an energy path downward to lower energy particles and ultimately to decay products that include the electron, kinetic energy and photons.

The decay path to lower quarks and kinetic energy combinations from the N series 13.43, 15.43, 17.43 and 19.43 reveal the resonances below:

Bottom quark+ resonances →Charm quark+resonances.

Charm quark+ resonances→Strange quark+resonances

Charm quark+ resonances→Down & Up quarks +resonances

Down and Up quarks→multiples of 0.6224 MeV

0.622 MeV→0.511 MeV electron + 0.111 MeV or photons

Aside:

N=10.333 is associated with 0.622 MeV. N=10.333-2*0.098=10.136 and N is the electron mass 0.511 MeV and 3*0.0986*3= 0.271. E=2.02e-5*exp(0.271)= 27.2e-6 MeV (the charge of the electron and proton). The difference value 0.111 MeV is the "spark" for fusion and the temperature of the universe that allows primordial fusion.

Obviously to satisfy the above criteria, the resonances must be differences between quark masses. Resonances are derived from the correlation of data from the table above that reduces PDG data and shows the series 13.43, 15.43, 17.43 and 19.43. The table below explores differences between the dominant N series (E=2.02e-5*exp(N)) and the measured PDG quark mass data on the right hand side of the diagram. The resonances (quanta) are differences that meet the criteria listed above. The PDG data for the strange quark is exactly 101.95 MeV as predicted.

Dominant N Series	E=e0*exp(N) (MeV)		Difference E (quanta marked in red)						Within range of PDG Data MeV
13.432	13.79701	minus	11.307					UP	2.4896
13.432	13.79701	minus	9.440					DOWN	4.3568
			88.150						
15.432	101.9469							STRANGE	101.95
			651.3442						
17.432	753.291		plus	6*88.15				CHARM	1282.19
19.432	5566.11		minus 88.15		minus 2*651.34			BOTTOM	4175.2715

The proton model is "built into" the universe. It was found that the energies inside the proton model above can simulate all the baryons using the concept that the kinetic energies in the proton are resonances. Energy values in the Schrodinger equation exp(-iEt/H) define resonances. Energy E can be represented as a circle with a probability collapse point 1. The energy is able to surge back and forth in the circle locked between P=1 points at the origin. Resonances are multiples of the base energy found in the proton. Here is a model of one of the baryons. The kinetic energy value resonances are designated as 2x, 3x, etc.

The circles are also Schrodinger type wave functions with energies Et/H moving in the circles (similar to sound from organ pipes).

The next task was to "test" whether the resonances and quark masses match the baryon mass data.

Each line of the table represents the simulated mass of one of the mesons. Using PDG data for quark assignments 1's were placed in the table for the quarks. Calculations take the 1's and multiplies them by the quark masses listed above the table. The resonance kinetic energy values (shaded in blue) from the discussion above are also listed at the top of the table. To the right of the table, the value negative width energy (MeV) is listed. The only unknowns are the resonance multipliers. Once these are adjusted, the meson energy is calculated by adding all the energies in the line. The measured accuracy is then compared with the difference between the PDG mass and the simulated mass. These two columns are listed as "accuracy" and "difference".

Long lived baryons

The literature proton quark assignment DOWN, UP, UP and the neutron quark assignment DOWN, DOWN, UP were placed in the table below. Next, the resonances developed above were added. Referring back to the proton model, we see that there are 3*0.69 MEV values and one neutrino of value -0.671 MeV (negative means this energy has exited the proton). These values were added to the proton line. When all the values are added across the table, the simulated mass exactly matches the PDG proton mass, 938.272 MeV. This was repeated for the neutron that decays to a proton. Before decay, it contains the -0.671 MeV neutrino and one additional 0.622 MeV particle. This sum is the difference 1.293 MeV between the neutron and proton and the simulated Neutron is exactly 939.565 MeV.

-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		Parity					
0	0		0	0		0	0		0.5	-0.5		-0.5	0.5		Iso-spin					
0.33	-0.33		-0.67	0.67		0.33	-0.33		0.33	-0.33		-0.67	0.67		Charge					
-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		spin Sz					
19.43	19.43		17.43	17.43	quanta	15.43	15.43	quanta	13.44	13.44	quanta	13.43	13.43	quanta I	N series		1			
b	bottom	field	c	charm	kinetic E	s	strange	kinetic E	d	down	kinetic E	u	u	kinetic E	Baryon					
															accuracy	**Simulated**	**Width**	diff	Width	Particle
4175.3	**4175.3**		**1282.2**	**1282.2**	**651.34**	**101.95**	**101.95**	**88.15**	**4.36**	**4.36**	**9.44**	**2.49**	**2.49**	**11.31**	data	**(MeV)**	(MeV)	(data-s	Sim	Name
					1			3		1	1		2	2		**938.272**	-20.3	0.0	-20.3	proton
					1			3		2	2		1	1		**939.565**	-20.3	0.0	-20.3	neutron

The width of the proton is called its weak field energy and has the value -20.3 MeV. The baryon simulations require a predictive variable that determines the weak energy. For the proton and neutron the variable is the number of resonances*5.08 MeV/resonance. We see that there is one resonance located in the 651.3 column, one in the 9.44 column and two in the 11.3 column. Four resonances*5.08/resonance= 20.3 MeV. This algorithm was used for the remainder of the width simulations, except sometime the width=resonances in the columns time 20.3 MeV/resonance.

Baryon simulations

New data was published in 2020 by the Particle Data Group. It was downloaded from the web site from a table entitled "rpp2020-sum-baryons [7]". The masses and widths are listed below. The PDG tables also contain property information including the quark assignments. After placing the quark assignments in the table below, the resonances were multiplied to simulate energy values that add across the table to the simulated baryon mass. Referring to the proton model, we know that the width energy is negative and must be included in the simulated mass. The mass plus resonances and width simulations must both fall within the accuracy listed by PDG. Using the 9.44 and 11.3 MeV resonances bring the accuracy of both mass and width within measurement accuracy. It many cases the masses are almost exact. There is excellent agreement between simulated mass, measured mass and simulated width.

-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		Parity					
0	0		0	0		0	0		0.5	-0.5		-0.5	0.5		Iso-spin					
0.33	-0.33		-0.67	0.67		0.33	-0.33		0.33	-0.33		-0.67	0.67		Charge					
-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		spin Sz					
19.43	19.43		17.43	17.43	quanta	15.43	15.43	quanta	13.44	13.44	quanta	13.43	13.43	quanta	N series		1			
b	bottom	field	c	charm	kinetic E	s	strange	kinetic E	d	down	kinetic E	u	u	kinetic E	Baryon					
															accuracy	Simulated	Width	diff	Width	Particle
4175.3	**4175.3**		**1282.2**	**1282.2**	**651.34**	**101.95**	**101.95**	**88.15**	**4.36**	**4.36**	**9.44**	**2.49**	**2.49**	**11.31**	data	**(MeV)**	(MeV)	(data-s	Sim	Name
					1			3		1	1		2	2		**938.272**	-20.3	0.0	-20.3	p
					1			3		2	2		1	1		**939.565**	-20.3	0.0	-20.3	n
					2			4		2	10		1	6	260	**1464.7**	-350.0	-24.7	-365.4	N (1440) 1/2+
					2			3		1	2		2	1	30	**1506.6**	-110.0	8.4	-101.5	N (1520) 3/2-
					2			4	2		3	1		3	80	**1567.7**	-150.0	-37.7	-162.4	N (1535) 1/2-
					2			5	1		1	2		3	85	**1675.7**	-125.0	-23.2	-121.8	N (1650) 1/2-
					2			5		2	4		1	2	45	**1654.0**	-145.0	18.5	-162.4	N (1675) 5/2-
					2			5		1	1		2	3	25	**1675.7**	-122.5	9.3	-121.8	N (1680) 5/2+
					2			6		1	3		2	6	350	**1715.2**	-200.0	9.8	-223.3	N (1700) 3/2-
					2			5		1	2		2	3	180	**1664.9**	-140.0	45.1	-142.1	N (1710) 1/2+
					2			6	2		8	1		4	320	**1680.7**	-275.0	34.3	-284.2	N (1720) 3/2+
					3					1	2		2	4	200	**1846.2**	-185.0	38.8	-182.7	N (1875) 3/2-
					3			1		1	4		2	8	300	**1876.6**	-300.0	3.4	-304.5	N (1880) 1/2+
					3				1		2	2		2	170	**1864.2**	-140.0	30.8	-142.1	N (1895) 1/2-
					3			1	2		5	1		4	280	**1903.6**	-210.0	16.4	-243.6	N (1900) 3/2+
					3			4		1	5		2	10	320	**2112.2**	-375.0	2.8	-365.4	N (2060) 5/2-
					3			3		1	4		2	6	220	**2070.9**	-260.0	29.1	-263.9	N (2100) 1/2+
					3			4		1	5		2	8	190	**2130.2**	-310.0	-25.2	-324.8	N (2120) 3/2-
					3			5	2		12	1		5	260	**2171.2**	-400.0	-1.2	-406.0	N (2190) 7/2-
					3			6	2		12	1		6	250	**2250.4**	-425.0	-0.4	-426.3	N (2220) 9/2+
					3			7	2		13	1		6	370	**2327.6**	-450.0	-42.6	-446.6	N (2250) 9/2-
					4			5	3		20			8	500	**2690.2**	-650.0	-40.2	-649.6	N (2600) 11/2
					1			7			1		3	5	10	**1221.4**	-117.0	10.6	-121.8	Δ(1232) 3/2+
					1			7		1	1		2	5	10	**1223.3**	-117.0	8.7	-121.8	Δ(1232) 3/2+
					1			7		2	1		1	5	10	**1225.2**	-117.0	6.8	-121.8	Δ(1232) 3/2+
					1			7		3	1			5	10	**1227.0**	-117.0	5.0	-121.8	Δ(1232) 3/2+
					2			4	3		10				200	**1520.6**	-250.0	-10.6	-243.6	Δ(1600) 3/2+
					2			4	3		4				80	**1585.7**	-130.0	24.3	-121.8	Δ(1620) 1/2−
					2			6	3		13				200	**1664.3**	-300.0	45.7	-304.5	Δ(1700) 3/2−
					3			1	3		9				220	**1898.0**	-250.0	-18.0	-243.6	Δ(1900) 1/2−
					3			1	3		13				185	**1854.6**	-335.0	27.9	-324.8	Δ(1905) 5/2+
					3			1	3		12				300	**1865.4**	-300.0	34.6	-304.5	Δ(1910) 1/2+
					3			1	3		12				220	**1865.4**	-300.0	54.6	-304.5	Δ(1920) 3/2+
					3			2	3		12				300	**1953.6**	-300.0	-3.6	-304.5	Δ(1930) 5/2−
					3			2	3		11				135	**1964.4**	-285.0	-31.9	-284.2	Δ(1950) 7/2+
					3			5	3		15				400	**2185.4**	-350.0	14.6	-365.4	Δ(2200) 7/2−
					4			1			11			11	700	**2395.3**	-500.0	54.7	-527.8	Δ(2420) 11/2
					1	1		3	1			1		8	0	**1116.4**	0.0	-0.8	0.0	Λ
					2		1			1	1		1	3	6.6	**1405.5**	-50.5	-0.4	-50.8	Λ(1405) 1/2−
					2	1		1	1		4	1			4	**1518.5**	-16.0	0.5	-20.3	Λ(1520) 3/2−
					1		1	9		1	10		1	9	160	**1548.0**	-200.0	52.0	-203.0	Λ(1600) 1/2+
					2		1	3		1			1		18	**1657.0**	-30.0	17.0	-20.3	Λ(1670) 1/2−
					2	1		3	1			1		6	30	**1664.0**	-70.0	26.0	-81.2	Λ(1690) 3/2−
					2	1		5	1		10	1		8	200	**1835.5**	-200.0	-35.5	-203.0	Λ(1800) 1/2−
					2	1		5	1		5	1		4	220	**1834.4**	-110.0	-44.4	-111.7	Λ(1810) 1/2+
					2	1		5	1		5	1		1	31	**1830.9**	-80.0	-11.4	-81.2	Λ(1820) 5/2+
					2	1		5	1		3	1		4	70	**1835.8**	-90.0	-10.8	-91.4	Λ(1830) 5/2−
					2	1		6	1		7	1		3	120	**1920.0**	-120.0	-30.0	-121.8	Λ(1890) 3/2+
					3	1		1	1		8	1		6	170	**2123.2**	-175.0	-23.2	-172.6	Λ(2100) 7/2−
					3	1		1	1		10	1		10	180	**2126.4**	-250.0	-36.4	-233.5	Λ(2110) 5/2+
					3	1		4	1		7	1		7	180	**2389.5**	-175.0	-34.5	-172.6	Λ(2350) 9/2+

Remainder of baryon simulations

-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		Parity					
0	0		0	0		0	0		0.5	-0.5		-0.5	0.5		Iso-spin					
0.33	-0.33		-0.67	0.67		0.33	-0.33		0.33	-0.33		-0.67	0.67		Charge					
-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		-0.5	0.5		spin Sz					
19.43	19.43		17.43	17.43	quanta	15.43	15.43	quanta	13.44	13.44	quanta	13.43	13.43	quanta I	N series		1			
b	bottom	field	c	charm	kinetic E	s	strange	kinetic E	d	down	kinetic E	u	u	kinetic E	Baryon					
															accuracy	**Simulated**	**Width**	diff	Width	Particle
4175.3	**4175.3**		**1282.2**	**1282.2**	**651.34**	**101.95**	**101.95**	**88.15**	**4.36**	**4.36**	**9.44**	**2.49**	**2.49**	**11.31**	data	**(MeV)**	(MeV)	(data-s	Sim	Name
																				Σ BARYONS (S
					1		1	4			7		2	1	0.14	**1189.6**	0.0	-0.3	0.0	Σ +
					1		1	4		1	6		1	2	0.048911	**1193.4**	0.0	-0.7	0.0	Σ 0
					1		1	4		2	5			3	0.06	**1197.1**	0.0	0.3	0.0	Σ −
					1		1	7			1		2		0	**1385.1**	0.0	-0.1	-1.0	Σ (1385) 3/2+
					2		1	2			10		2	8	240	**1569.2**	-200.0	15.8	-203.0	Σ (1660) 1/2+
					2		1	3		2	5				80	**1655.3**	-70.0	19.7	-71.1	Σ (1670) 3/2−
					2		1	4		2	13				200	**1737.8**	-150.0	12.2	-152.3	Σ (1750) 1/2−
					2		1	4		2	10				40	**1739.9**	-120.0	35.1	-121.8	Σ (1775) 5/2−
					2		1	5		2	5			1	0.12	**1909.9**	-0.1	0.1	-4.1	Σ (1910) 3/2−
					2		1	6			7		1	3	115	**1915.6**	-120.0	1.9	-121.8	Σ (1915) 5/2+
					3		1				7		2	7	65	**2035.0**	-175.0	-2.5	-172.6	Σ (2030) 7/2+
					3		1	2		1	4		1	3	160	**2210.7**	-105.0	34.3	-101.5	Σ (2250)
																				Ξ BARYONS (S
					1		2	4			2		1	8	0.04	**1315.4**	0.0	-0.6	-5.6	Ξ 0
					2		2				3		1		-7.96	**1536.2**	-4.8	-4.4	-2.6	Ξ (1530) 3/2+
					2		3	1							10	**1677.8**	-25.0	12.2	-20.3	Ξ (1690)
					2		2	4					1		31	**1842.8**	-24.0	-19.8	-20.3	Ξ (1820) 3/2−
					2		2	5			4		1		70	**1928.1**	-60.0	21.9	-60.9	Ξ (1950)
					2		2	6					1		40	**2019.1**	-20.0	5.9	-20.3	Ξ (2030)
																1.4	0.0		0.0	Ω BARYONS (
					1		3	7			6			4	0.18	**1671.9**	0.0	0.6	-5.6	Ω −
					2	1		6	1		8	1			7.9	**2012.2**	-6.5	0.2	-5.1	Ω (2012)−)
					3	1		3	1		2	1			54	**2296.8**	-55.0	-44.8	-50.8	Ω (2250)−)
															0	**0.9**			-0.511	CHARMED BA
				1	2					1			1		1.76	**2592.1**	-2.6	0.2	-1.0	Λc (2595)+
				1	2					1	4		1		0.38	**2627.8**	-1.0	0.3	-3.1	Λc (2625)+
				1	2			3		1			1	5	28.6	**2843.1**	-68.0	13.0	-71.1	Λc (2860)+
				1	2			3		1	3		1	0	2.08	**2883.3**	-5.6	-1.7	-2.6	Λc (2880)+
				1	2			4		1	1		1		14.6	**2939.9**	-20.0	-3.3	-15.2	Λc (2940)+
				1	1			5		1	1		1	6	0.46	**2453.7**	-1.9	0.1	-6.1	Σc (2455)
				1	1			3		1	17		1	15	0.81	**2519.5**	-14.9	-1.0	-16.9	Σc (2520)
				1	2			3		1			1	2	53	**2809.1**	-74.5	-8.1	-71.1	Σc (2800)
				1	2					1			1	5	2.68	**2646.1**	-1.3	-0.5	-3.6	Ξc (2645)
				1	2			1		1	2		1	9	5	**2795.8**	-8.9	-3.4	-6.1	Ξc (2790)
				1	2			2		1	3		1	2	0.82	**2817.3**	-2.5	-0.5	-3.1	Ξc (2815)
				1	2			3		1			1	10	18.84	**2963.0**	-11.7	3.4	-7.7	Ξc (2970)
				1	2			5		1				3	4.6	**3060.2**	-7.9	-4.3	-5.1	Ξc (3055)
				1	2			5			3		1	2	3.3	**3075.8**	-2.4	1.4	-4.6	Ξc (3080)
				1	2		2							5	10	**2775.6**	-75.0	-9.7	-71.1	Ωc (2770)0
				1	2		2	2			4				2.06	**3002.2**	-4.5	-1.8	-2.0	Ωc (3000)0
				1	2		2	3							9.74	**3052.1**	-1.2	3.1	-2.6	Ωc (3050)0
				1	2		2	2			5			5	1.36	**3065.6**	-3.5	-0.1	-4.6	Ωc (3065)0
				1	2		2	2			2			10	3.6	**3091.3**	-8.7	-1.3	-7.2	Ωc (3090)0
				1	2		2	3			6			1	0	**3119.5**	-2.6	-0.4	-3.1	Ωc (3120)0
																				DOUBLY CHA
																				BOTTOM BAF
	1				2			4		1	8		1		0.42	**5913.7**	-0.7	-1.5	-0.7	Λb(5912)0
	1				2			4		1	4		1	4	0.19	**5920.7**	-0.6	-0.9	-1.1	Λb(5920)0
	1				3					1			1	1	2.8	**6146.8**	-2.9	-0.6	-2.0	Λb(6146)0
	1				3					1	1		1	1	3.6	**6156.2**	-2.9	-3.2	-2.0	Λb(6152)0
																				JP = 5 +
																				Σb
	1				3								2		15.4	**6105.2**	-31.0	-9.4	-30.5	Σb(6097)+
	1				3					2					11.6	**6109.0**	-29.0	-11.0	-30.5	Σb(6097)−)
	1				2		1	4					1		0.02	**5933.3**	0.0	1.7	-3.1	Ξ ′ (5935)−
	1				2		1	4			1		1	1	1.56	**5953.6**	-0.9	-1.3	-3.6	Ξb(5945)0
	1				2		1	4		1	1			1	0.92	**5955.4**	-1.7	-0.1	-3.6	Ξb(5955)−)
	1				3		1			1				1	23	**6246.3**	-18.0	-15.9	-2.0	Ξb(6227)
																				EXOTIC BARY
				2	2		1	4							24	**4319.9**	-10.0	-8.0	-3.1	Pc (4312)+
				2	2		1	4			12			12	240	**4389.5**	-205.0	-9.3	-182.7	Pc (4380)+
				2	2		1	5			3			2	28	**4457.5**	-21.0	-17.5	-4.6	Pc (4440)+
				2	2		1	5			2			3	20	**4458.8**	-6.4	-1.5	-5.1	Pc (4457)+

Conclusions

The proton and neutron models are the basis for resonances in all baryons. The correlation that lead to the proton model, N=13.43,15.43,17.43 and 19.43 is fundamental to not only the proton and neutron but all the baryons and mesons.

One way to think about this is that the proton is a manifestation of the laws of nature. The baryons get extra energy from the accelerator but assume the basic form of the proton. Resonances of the basic proton energy values are energized similar to the way an organ pipe produces sound when energized. Nature is using the kinetic energy of the accelerator to produce resonances similar to the proton.

Decay times are simply H/width but a model helps understand why. The model proposed is that a radius is formed based on the width energy. An orbit is formed with velocity determined by half width energy. The decay occurs as a quark bundle circles the radius at velocity V once. At that point it the Schrodinger P should be 1. It is exactly that for proton and neutrons and this underlies their stability. The remaining baryons have incomplete wave functions. Width is associated with resonances. Each resonance produces a certain amount of width energy.

I used the insights gained to write another paper entitled "Particle-space, a unifying theory" currently being published on Academia.edu.

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Appendix

Can decay times be predicted?

If a new baryon is discovered what will its decay time be? There is some chance you can predict it if you fit it into the table based on its component quarks and properties. Some component quark combinations have larger width energy. Once you know the mass and quarks, you can find its resonances that add to its mass. The number of resonances times 20.3 MeV/resonance will yield the width. Unfortunately for some parts of the table each resonance only gives 10.15 MeV/resonance. This makes decay times uncertain.

Decay time prediction is improbable but there is a terrific "consolation prize". We can understand the physics of mesons and baryon decay time measurements using a model similar to the proton.

Why is Neutron decay half time 661 seconds?

Imagine that you are an intelligent proton trying to produce the universe with your other exp(180) proton friends. You start with only 10.15 MeV of kinetic energy/proton and realize that kinetic energy for expansion is being depleted at the rate of E=10.15*(0.051/time)^0.5. At only 540 seconds the energy available has fallen to 0.11 MeV but you want the universe to last 13 billion years. You need more energy and decide to use fusion energy to refuel. The value 0.11 MeV is interesting because it is the value 0.622-0.511=0.111 MeV (the energy released with the energy 0.622 decays to an electron). Your universe was originally mainly neutrons but they are decaying and the temperature associated with 0.111 MeV is low enough to prevent photo disintegration of the atoms you create. You can now fuse about 25% of everything to produce Helium4. All of a sudden about 25% of the He4 fusion energy (7.07 MeV) is available (about 2.8 MeV) to refuel your universe. This energy will last a while because expansion kinetic energy is now =2.8*(540/time)^0.66 (the exponent changes because it no longer a plasma). When the time is about 13 billion years, the temperature associated with the remaining energy is about 3 degrees. Apparently the proton is a sycophant of the anthropomorphic principle. The whole plan depended on having neutrons available after 539 seconds. If they decayed any faster, the universe would be too cool now. The half time(1) for neutrons is 660 seconds, the right time to save your design.

			Start	He4 transition	He4 Spike	Now	
KE MeV			10.15	0.099	2.81E+00	3.33E-10	
KE expansion algorithm			10.15*(0.0511/time)^.5		2.81*(539/time)^0.666		
Expansion Time (sec)		Time (sec	0.052	539	539	4.32E+17	
Temp before He4 spike K=ke/(1.5*B)			7.87E+10	7.66E+08		0.35	settle back r
R meters=8.05e12*10.15/(E*pi)			8.04E+12	8.26E+14		R=4.21e15*2.81/(3.33e-10)	
R after spike=8.23e14+2.8*1.6e-13/(3.6e-42*exp(90)*exp(60)					1.20E+16	3.55E+25	
Temperature after He4=KE/(1.5*B)					2.18E+10	2.58	
baryon photon ratio					6.98E-10		
		Stars energy delta radius (m)				4.5E+24	
		Temperature now (K)				2.73	
		Radius end of expansion (m)				4.00E+25	

(1) Decay is a probabilistic process characterized by half time. The decay is exponential and the half time is the time when the probability of decay is 0.5. Probability is related to the natural number e to a power called ratio. Probability is always 1 or lower. Probability of neutron remaining= half time*e^ratio. The value e^ratio is written exp (ratio).