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Title: A Fundamental Model of Atomic Binding Energy

Abstract

Reference 2 presents the author's attempt to "crack the information theory code" underlying nature. Once the energy components were understood, a model for the neutron and proton was developed. It is presented in Reference 2 and repeated below under the next heading. Using reference 1 for gravity, reference 2 also proposes an approach to unification of the four forces. The proton model shows that there is a 10.15 mev orbit that losses energy and is responsible for the binding energy curve. This paper contains the analysis.

Literature cites "water drop" models for binding energy that are admittedly empirical. Quantum physicists have suggested that there should be "electron like" shells inside atoms but to the author's knowledge they remain unclear. If there are shells the nucleons should fall into lower energy states releasing the remainder as binding energy. The author explored this possibility. Empirically, the model was successful but no explanation could be found for why a nucleon occupied a given shell.

The first part of the binding energy curve rises quickly and then levels off as saturation occurs. When the author compared the shape of the curve to a probability based model a fundamental relationship was discovered. The relationship is almost identical to the fundamentals presented in reference 2.

Information contained in the proton mass table

Information from the proton mass model is used to understand fundamental interactions.

ll 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	Gravitational	spin
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		0.5
12.432	5.076	10.432	0.687							-0.69	
13.432	13.797	15.432	101.947	13.797	78.685				-101.95		0.5
12.432	5.076	10.432	0.687							-0.69	
13.432	13.797	15.432	101.947	13.797	78.685				-101.95		-0.5
12.432	5.076	10.432	0.687							-0.69	
		-0.296	-2.72E-05			10.151		20.303	expansion ke		
harge		equal and opposite charge						0.000	expansion pe		
10.408	0.67	0.075		0.000	0.000	-0.671	0.671	v neutrino			
-10.333	0										
ates here to form proton and electron				129.541	799.251	**938.272013**	**PROTON MASS**				0.5
10.136	0.51	10.333	0.62	**0.511**	0.111				5.44E-05	-0.622	0.5
0.197	2.47E-05	0.296	2.72E-05	**ELECTRON**			2.47E-05	e neutrino			
				130.052	0.111		0.671	20.303	-957.185	-2.683	
90.000		90.000						Total m+ke	Total fields		
								Total positive	Total negative		
								959.868	-959.868	0.00E+00	difference

Values underlying four fundamental interactions come from the table above.

	Mass (m) (mev)	Ke (mev)	gamma (g)	R meters	Field (E (mev)
Gravity	129.541	10.151	0.9273	**1.0584E-14**	-2.683
Electromagn	0.511	1.36E-05	0.99997	**5.2911E-11**	-2.72E-05
Strong	129.541	799.251	0.1395	**2.0928E-16**	-957.18
Weak	939.565	10.151	0.9893	**1.4211E-15**	-20.303

Orbital kinetic energy in the proton

Physicists believe there are three quarks inside the proton and it is reasonable to model them as a small bundle of mass and kinetic energy contained by the strong interaction. The quark mass plus kinetic energy from the model is 129.5+799.25-.67=928.12 mev. There is however, an additional kinetic energy of 10.15 mev that makes up the total mass of the proton (938.27 mev). This value changes during fusion.
As an aside, based on the proton mass model the weak field energy does not result from a separate frequency transition. (In some literature this is called the strong residual force, but we are seeking the energy change responsible for binding energy). The proton and neutron mass models have a total energy of 959.86 mev, but the neutron only has only 939.56 mev. The total energy balance is zero if we consider the 20.3 deficit (959.86-939.56) as a field that surrounds the central mass (130.834 mev) similar to the manner in which the electromagnetic field surrounds the electron and proton. As quark bundles fall into the weak field, the released energy binds the neutrons and protons inside atoms.

A top-down approach to fundamental release of atomic energy

Reference 2 identifies 1.5e78 as the number of protons in the universe based on the results of WMAP [9]. This makes the probability (P) of one proton 1/1.5e78. Nature uses Shannon [15] type information theory and makes N=- ln(P) a fundamental number of nature (ln stands for natural logarithm). Reference 2 shows how nature's particles relate to N=180. Energy and N are related by the relationship E=e0*exp(N) and (for example) the number N=10.136 represents the electron since E=2.025e-5*exp(10.136)=0.511 mev, the energy of the electron. In other words e0/P is the electron energy where e0=2.025e-5 mev and P=1/exp(10.136).

The fundamentals of atomic binding energy appear to be based on the same approach. First the probability of a proton in (for example) lithium 3 is given as P=1/exp(2/3). The 2 means there are two types of particles (protons and neutrons) and 3 is of course the atomic number for lithium. Next N=-ln(P)=2/3. Note that in this case N is a number smaller than 1. Following a similar approach in the paragraph above, energy would be modified by P to give the binding energy of the proton at atomic number 3. The value e0 is 10.15 mev for binding energy, the value given above for "kinetic energy in the proton orbit". Binding energy for the proton contribution to atomic number 3 is 10.15/exp(2/3)=5.21. In the table below the "Fundamentals of protons" is the approach that is used for "Fundamentals of atomic binding energy". Note that for the heaviest atoms can have 110 protons which gives a potential release of 9.97 mev of atomic binding energy, indicating that the curve “saturates” at 10.15 mev.

Fundamentals of protons				
protons	P =1/protons	N=- lnP	E=e0*exp(N)	E=e0*exp(N)
1.49E+78	6.71E-79	180	e0/P=2e-5/P	e0/P=2e-5/P
	P=1/exp(180)=exp(-N)			
	3.96E-05	10.136	0.511	Electron
Fundamentals of atomic binding energy				
			e0*P=10.15*P	e0*P=10.15*P
protons	P=1/exp(2/3)=exp(-N)	N=-ln(P)	10.15*P	10.15*exp(-2/3)
3	0.51	2/3	5.21	5.21
110	0.98	0.02	9.97	9.97

The values based on the fundamentals above will be called the “fundamental release” of atomic energy.

Consider now that neutrons are re-converted protons and also release energy as they fuse. The following calculations illustrate that the total fundamental release is the weighted contribution from the protons and neutrons. The weighted average is darkened in the table below.

protons p	(10.15*EXP(-2/protons))	neutrons n	(10.15*EXP(-2/neutrons))	(p*10.15*EXP(-2/p)+n*(10.15*EXP(-2/n)+E))/(p+n) (weighted average)
1	1.374			1.374
2	3.734	2	3.734	3.734
3	5.211	4	6.156	5.751
4	6.156	5	6.804	6.516
5	6.804	6	7.273	7.060
6	7.273	7	7.627	7.464
7	7.627	8	7.905	7.775
8	7.905	9	8.127	8.023
9	8.127	10	8.310	8.224
10	8.310	11	8.463	8.390
110	9.967	272	10.076	10.044

This isotope of lithium has 4 neutrons and the calculation above gives a total binding energy of 5.751 mev. This is close to the NIST [8] value of 5.644 mev but the difference is significant and there are two corrections needed. The binding energy curve is based on two additional processes: retained energy and isotope number.

The re-conversion process

Reference 2 reviewed the neutron to proton decay (conversion) process N → P e- av ke (e- , av and ke refer to the electron, the anti-neutrino and kinetic energy required to balance the process). The electron quad table (reproduced below) indicates that the electron initially has 0.111 mev of kinetic energy (explained in reference 2).

As a proton, the electron quad of the proton mass model contains these energies:

(0+1)			-0.296	-2.72E-05					20.303	expansion ke	
Total proton charge			equal and opposite charge						0.000	expansion pe	
	10.408	0.67	0.075		0.000	0.000	-0.671 →	0.671 v neutrino			
-10.33	-10.333	0									
Neutron separates here to form proton and electron					129.541	799.251	**938.272013**	**PROTON MASS**			
10.33	10.136	0.51	10.333	0.62	**0.511**	0.111				5.44E-05	-0.622
	0.197	2.47E-05	0.296	2.72E-05	**ELECTRON**		→	2.47E-05 e neutrino			
					130.052	0.111		0.671	20.303	-957.185	-2.683
	90.000		90.000						Total m+ke	Total fields	
									Total positive	Total negative	
									959.868	-959.868	0.00E+00

But as a neutron, the electron quad of the mass model contains these energies:

10.408	0.67	0.075		0.000	0.000					
-10.333										
10.333	0.6224	0	2.02E-05	0.6224	0.000		2.02E-05		-2.02E-05	
0	2.02E-05	10.333	0.6224							-0.6224
				130.163	799.251	**939.5653531**	2.02E-05	20.303	-957.185	-2.683
90.000 sum		90.000				**NEUTRON MASS**		Total m+ke	Total fields	
								Total positive	Total negative	
								959.868	-959.868	0.000E+00
						130.16				

The decay energy balance can be written N (939.565)→ P (938.272) + e- (0.511 +.111) +av (0.671). (This accounts for the neutron/proton mass difference of 1.293 mev). This process is reversed during fusion. The neutrino energy of 0.671 mev is ejected according to the binding energy model, but regained. At high temperature and pressure there is a chance that the electron/proton can regain the 0.111 ke lost from the decay. The reverse process for the proton to neutron re-conversion is as follows: P (938.272) + e- (0.511) + ke (0.111) → N (938.27) + v (0.622). The re-converted neutron undergoes a properties re-conversion and reverts to a neutron from the standpoint of charge, etc. The kinetic energy it absorbs is the "difference kinetic energy" (0.111=27.2e-6+.622-0.511-2.4e-5). Since it is a subtraction of four values linked with the electron quad, some of the values may contain properties (spin and charge) that balance the re-conversion. The proton actually gains the two neutrinos lost in the decay process from a neutron to a proton (energy 0.6709+0.6224=1.293 mev. The electron is absent after the conversion to a neutron. It is converted to energy 0.622 mev energy 0.511 mev+0.111 mev absorption. Re-conversion and a gain of energy on the order of 0.111 are pre-requisites for fusion. The process involves new-neutrons and protons falling into weak field energy. More than half of the incoming protons become neutrons because neutrons can lose more energy. (See the paragraph below entitled "Prediction of excess neutrons over protons…"). The other portion of the incoming protons is accepted without conversion.

Summarizing, the requirement for fusion is that the environment must provide energy. In this model, if the electrons and protons gain 0.111 mev and are in contact they fuse. This amount of energy is large compared to the kinetic energy available from even a very hot environment. For example the sun's core temperature of 1.5e7 degrees K provides 0.0022 mev. (A probabilistic process appears to limit the reaction rate. A simplified way to think about this is a Boltzmann type calculation like P=exp(-.009/0.002), where -0.009 mev is a barrier energy and 0.002 mev is kinetic energy from the environment). The low probability that the value 0.111 mev will be achieved helps determines the low reaction rate at this temperature (a description of solar fusion is contained in reference 14).

Retained kinetic energy

The incoming protons gain energy from their environment (i.e., the core of the sun). When energy conditions allow, protons are accepted into the developing atom and they retain part of the supplied energy. After considering the fundamental release, the binding energy falls with increasing atomic number (and is quite evident for large atomic number) as more energy is retained inside the atom. The atom retains energy of -0.1/4 mev for each proton. This is close to the value 0.111 given in the proton mass model as the kinetic energy of the electron. This energy may be related to compressing the charges (literature refers to a coulomb barrier since protons resist bringing more positive charge into the nucleus). The overall retained energy is the number of protons times the retained energy per proton pair.

Correction for isotope number

Without a second correction, the difference between the published and predicted value *cycles* within one atomic number for the several isotopes of that atom. The cycle was characterized by the retained energy of -0.004*isotope number (n) and n was assigned as follows. The first isotope was normally given the value n=1 and incrementally increased (neutrons minus protons) as isotopes became more massive. The correction could be considered empirical but with more work might be fundamental.

Binding energy results

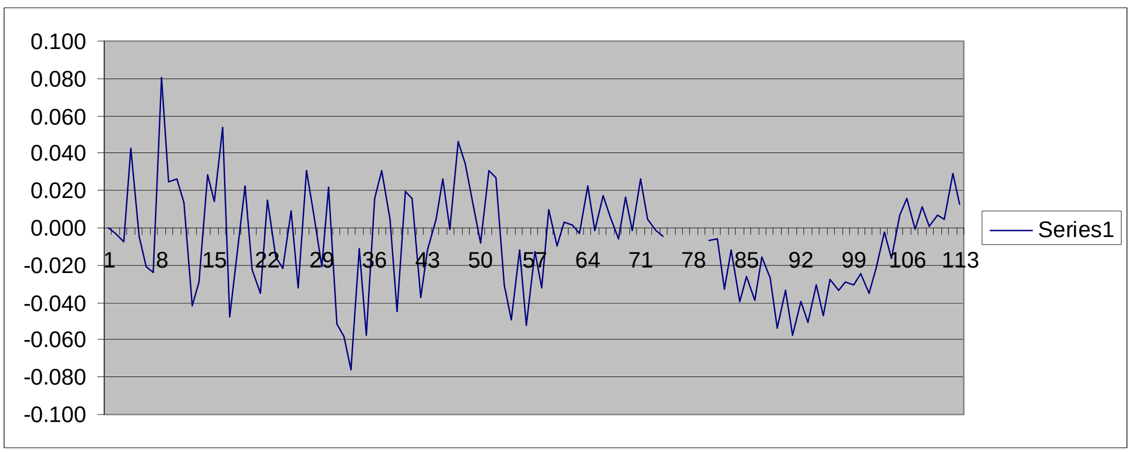
The following data is a combination of NIST [8] data for published binding energy compared against the author's binding energy model. Two corrections were made to the fundamental release. First the retained energy and second the small retention for isotope number.
There was another correction sometimes required that the author believes can be easily identified. Some of the predicted values are multiples of 0.111 mev higher or lower (this is the energy associated with the electron kinetic energy that initiates fusion) and were subtracted out. This correction only appears in the steeply rising portion of the curve. In addition, there were two atoms that were obviously different. The fundamental release from Helium (2,2) was exactly doubled. Secondly, it appears that Carbon (6,6) retains an extra 0.622 mev (a neutrino like energy) for some reason.

							Simple probability model				
						average	0.007		-0.100	electrostatic retention	
					Published	stand dev	0.025		-0.004	isotope n correction	
					Binding Energy		Pub BE-pred	Energy	Isotope N		Fundamenta
		protons	neutrons	isotope n	mev	.11 correctio	mev	retention	correction	prediction	Release P*1(
H		1	0	1	0.000		0.000	0	0	0.000	0.000
D		1	1	2	1.115	-1	-0.003	-0.025065	-0.008	1.118	1.151
T		1	2	1	2.915	1	-0.004	-0.025065	-0.004	2.919	2.948
He		2	1	1	2.490	-3	0.042	-0.05013	-0.004	2.448	2.502
		2	2	1	7.075	-2	-0.005	-0.05013	-0.004	7.080	7.134
Li		3	3	1	5.334	3	-0.021	-0.075195	-0.004	5.355	5.434
		3	4	2	5.644	1	-0.024	-0.075195	-0.008	5.668	5.752
Be		4	5	1	6.492	1	0.080	-0.10026	-0.004	6.412	6.516
B		5	5	1	6.476	-1	0.024	-0.125325	-0.004	6.452	6.581
	0	5	6	2	6.952		0.137	-0.125325	-0.008	6.815	6.949
C		6	6	3	7.681		-0.051	-0.15039	-0.012	7.732	7.895
		6	7	1	7.491	3	-0.042	-0.15039	-0.004	7.533	7.687
		6	8	2	7.558	2	-0.030	-0.15039	-0.008	7.587	7.746
N		7	7	1	7.477	1	0.028	-0.175455	-0.004	7.448	7.628
		7	8	2	7.717	2	0.014	-0.175455	-0.008	7.704	7.887
O		8	8	1	7.977	3	0.054	-0.20052	-0.004	7.924	8.128
		8	9	2	7.767		0.064	-0.20052	-0.008	7.703	7.912
		8	10	3	7.796		-0.010	-0.20052	-0.012	7.806	8.019
F		9	10	1	7.793	-1	0.022	-0.225585	-0.004	7.772	8.001
Ne		10	10	1	8.033	1	-0.023	-0.25065	-0.004	8.056	8.311
		10	11	2	7.985		-0.036	-0.25065	-0.008	8.020	8.279
		10	12	3	8.105		0.014	-0.25065	-0.012	8.090	8.353
Na		11	12	1	8.123		-0.016	-0.275715	-0.004	8.139	8.419
Mg		12	12	2	8.262		0.089	-0.30078	-0.008	8.172	8.481
		12	13	3	8.235		0.009	-0.30078	-0.012	8.226	8.538
		12	14	4	8.354		0.079	-0.30078	-0.016	8.275	8.592
Al		13	14	1	8.342		0.030	-0.325845	-0.004	8.312	8.642
Si		14	14	2	8.448		0.120	-0.35091	-0.008	8.329	8.688
		14	15	3	8.458		0.090	-0.35091	-0.012	8.368	8.731
		14	16	4	8.538		0.133	-0.35091	-0.016	8.405	8.772
P		15	16	1	8.490		0.060	-0.375975	-0.004	8.430	8.810
S		16	16	1	8.494		0.053	-0.40104	-0.004	8.441	8.846
		16	17	2	8.506		0.035	-0.40104	-0.008	8.471	8.880
		16	18	3	8.599	1	-0.012	-0.40104	-0.012	8.611	9.024
		16	20	5	8.604		0.053	-0.40104	-0.02	8.551	8.972
Cl		17	18	1	8.528		0.016	-0.426105	-0.004	8.513	8.943
		17	20	3	8.592		0.031	-0.426105	-0.012	8.561	8.999
Ar		18	18	1	8.521		0.004	-0.45117	-0.004	8.516	8.972
		18	20	3	8.628		0.067	-0.45117	-0.012	8.562	9.025
		18	22	5	8.622		0.019	-0.45117	-0.02	8.602	9.074
K		19	20	6	8.564		0.015	-0.476235	-0.024	8.549	9.050
		19	21	2	8.552		-0.037	-0.476235	-0.008	8.589	9.073
		19	22	3	8.595		-0.012	-0.476235	-0.012	8.608	9.096
Ca		20	20	6	8.552		0.004	-0.5013	-0.024	8.548	9.073
		20	22	3	8.629		0.026	-0.5013	-0.012	8.604	9.117
		20	23	4	8.619		-0.001	-0.5013	-0.016	8.620	9.138
		20	24	5	8.682		0.046	-0.5013	-0.02	8.636	9.157
		20	26	6	8.703		0.034	-0.5013	-0.024	8.669	9.194
		20	28	7	8.710		0.011	-0.5013	-0.028	8.699	9.228
Sc		21	24	1	8.637		-0.009	-0.526365	-0.004	8.646	9.176
Ti		22	24	1	8.668		0.030	-0.55143	-0.004	8.638	9.194
		22	25	2	8.678		0.026	-0.55143	-0.008	8.652	9.211
		22	26	3	8.745		-0.030	-0.55143	-0.012	8.775	9.339
		22	27	4	8.738		-0.049	-0.55143	-0.016	8.787	9.355
		22	28	5	8.787		-0.012	-0.55143	-0.02	8.799	9.370
V		23	27	6	8.717		-0.052	-0.576495	-0.024	8.769	9.370
		23	28	7	8.768		-0.012	-0.576495	-0.028	8.780	9.385
Cr		24	26	6	8.712		-0.032	-0.60156	-0.024	8.744	9.370
		24	28	3	8.795		0.009	-0.60156	-0.012	8.785	9.399
		24	29	4	8.785		-0.010	-0.60156	-0.016	8.795	9.412
		24	30	5	8.807		0.003	-0.60156	-0.02	8.804	9.426
Mn		25	30	6	8.789		0.001	-0.626625	-0.024	8.788	9.438
Fe		26	28	6	8.746		-0.003	-0.65169	-0.024	8.750	9.425
		26	30	3	8.809		0.023	-0.65169	-0.012	8.787	9.450
		26	31	4	8.793		-0.001	-0.65169	-0.016	8.795	9.462
		26	32	5	8.819		0.017	-0.65169	-0.02	8.802	9.474
Co		27	32	6	8.790		0.006	-0.676755	-0.024	8.784	9.485
Ni		28	30	6	8.742		-0.006	-0.70182	-0.024	8.748	9.474
		28	32	3	8.798		0.017	-0.70182	-0.012	8.782	9.495
		28	33	4	8.787		-0.001	-0.70182	-0.016	8.788	9.506
		28	34	5	8.820		0.026	-0.70182	-0.02	8.794	9.516
		28	36	7	8.810		0.005	-0.70182	-0.028	8.806	9.535

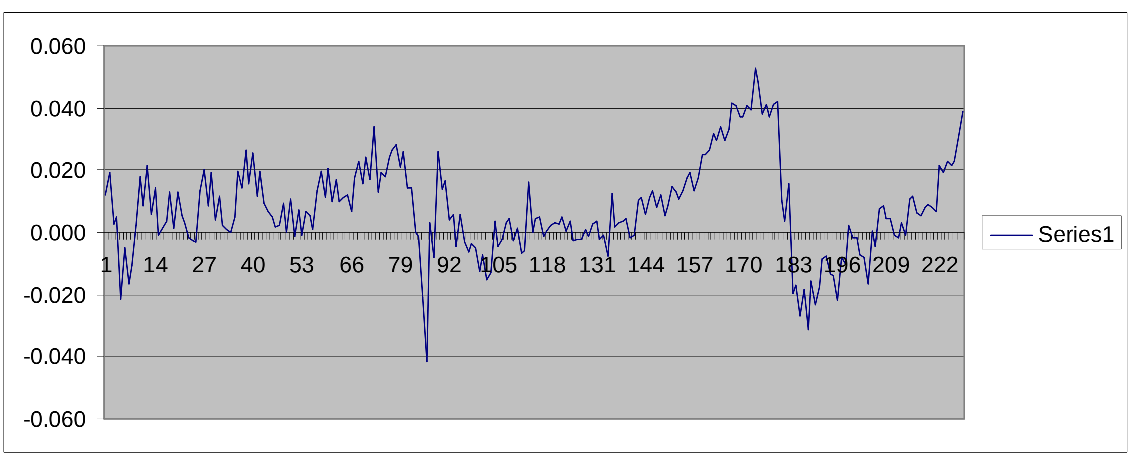
The fundamental release in yellow contains an extra retention of 0.111 mev. All the others are normal.

The remainder of the atoms were calculated but not presented here for brevity. For all 345 atoms, the standard deviation was 0.021 and the average from zero was 0.003 mev.

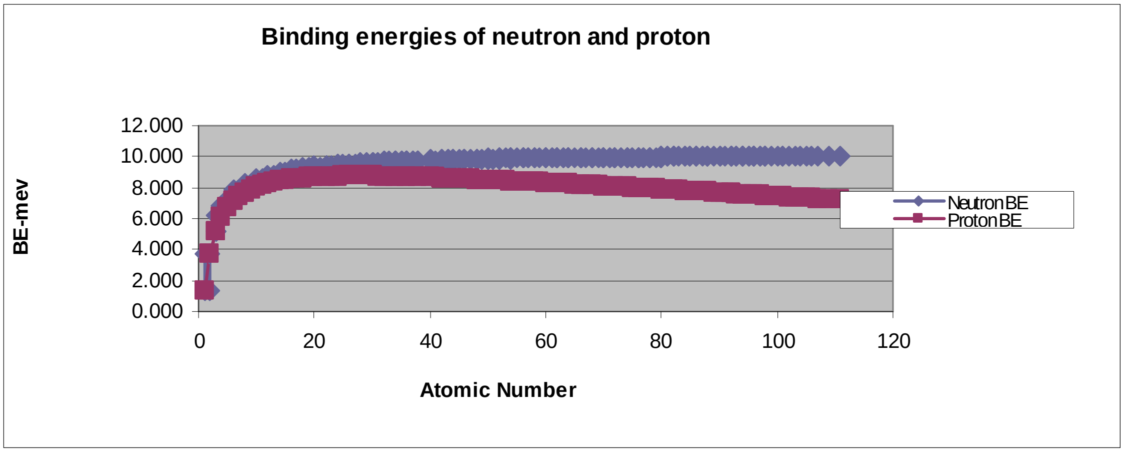
Since the predicted values are very close to the published binding energy, the points overlie each other and there was no need to present the predicted curve. The more meaningful graph is the following deviation for the first 113 atoms (including the isotopes). The vertical axis is published binding energy minus predicted binding energy in mev.



And for the remaining atoms and isotopes, the following graph shows the deviations. The vertical axis is mev, indicating that the predictions are within standard deviation 0.021 mev overall.



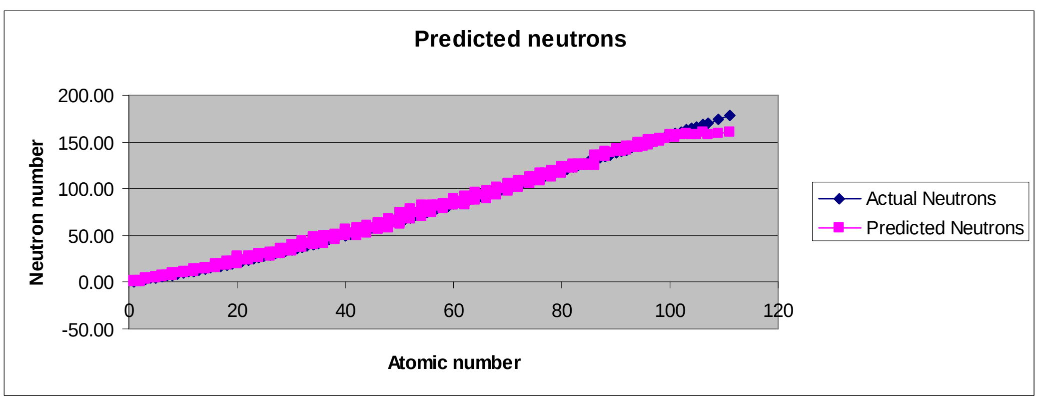
It is instructive to show the binding energy for the proton and neutron separately.



Prediction of neutron excess over protons with increasing atomic number

Excess neutrons are produced because they can give up more energy. Prediction of the excess neutrons is simply a result of the energy that the protons retain. Based solely on this parameter, the number of neutrons can be predicted from the number of protons.

Neutrons=protons+protons/(EXP(1.32/(Eretained))



Summary

A proposal regarding how nature releases binding energy is offered as verification of the proton kinetic energy value 10.15 mev. This value appears in the proton mass model presented in reference 2. Reference 2 offers an internally consistent approach to the four forces of nature and this paper extends the basic approach to binding energy.

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