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An Orthogonal Mechanical Model of Stable Nuclei

Dana George Cottrell*

Retired Electrical Engineer, 7269 W. Brubeck Ct. Tucson, Arizona 85743
*Corresponding author: danacottrell@sbcglobal.net

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Abstract The following article presents a mechanical model approach for stable atomic nuclei based on a symmetrical orthogonal arrangement of protons and neutrons. This rigid approach lends support to nuclear pairing, shell modeling (without gaps), and symmetry concepts of nuclear structure and does not support independent particle models where nucleons move in mean free paths within the nucleus. The disparity between the number of stable nuclides with an even number of protons and those with an odd number of protons is examined and then used to postulate possible orthogonal mechanical models of nuclei. The ability to predict subsequent abundant nuclei based on the pattern developed for the first twenty or so nuclides gives credence to the proposed model. To further validate this pattern, an electron orbiting arrangement about the orthogonal axes is developed which adapts the pattern to the periodic table. Each vertical column in the periodic table makes up a related group of elements based on their chemical behavior. This article will show how electron orbiting patterns on two axes group elements in accordance to the Periodic Table and opens the door for pushing physics beyond the standard mode (BSM). In the interest of simplicity, binding energies and energy levels using quantum and wave mechanics are not described in this article.

Keywords: *nuclear models, nuclear modeling, mechanical model of stable nuclei*

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1. Introduction

The following Table of Nuclides [1] show the abundance of stable nuclides. A significant number of nuclei with odd atomic numbers (Z) do not show stable isotopes as apposed to those with even atomic numbers. This suggests that when constructing a mechanical model of the nucleus, there would be a slight, or perhaps a significant, difference between the models of odd Z and even Z nuclei.

One novel approach is to construct an orthogonal structure (arranging nucleons on an x, y and z axis), where one structure is based on even Z atomic nuclei and the other is based on odd Z atomic nuclei. This can be accomplished by beginning the structure with neutron(s) in the center for even Z and a proton in the center for odd Z. One test for this theory is to demonstrate that the abundant isotope of a nuclide can be predicted for the first twenty or so nuclides as the model develops from helium through calcium. As can be seen from the following model development, the resulting predictability supports a symmetrical, orthogonal arrangement approach for a mechanical model of nuclei.

Using this approach, an electron orbiting mechanism is developed whereby electrons spin (orbit) two of the axis. Elements with similar orbiting characteristics are then grouped in such a way as to match those fitting the vertical columns of the Periodic Table.

The high correlation coefficients of the orthogonal structures and the electron orbiting arrangements for the first twenty or so Z nuclei will lend credibility to this proposed mechanical model of atomic nuclei.

Table 1. Table of Nuclides

Nuclide	Abundance%	Nuclide	Abundance%	Nuclide	Abundance%
$_{8}O^{16}$	**99.76**	**$_{14}Si^{28}$**	**92.21**	**$_{18}Ar^{40}$**	**99.6**
$_{8}O^{17}$	0.037	$_{14}Si^{29}$	4.7	**$_{19}K^{39}$**	**93.1**
$_{8}O^{18}$	0.204	$_{14}Si^{30}$	3.09	$_{19}K^{41}$	6.88
$_{9}F^{19}$	**100**	**$_{15}P^{31}$**	**100**	**$_{20}Ca^{40}$**	**96.97**
$_{10}Ne^{20}$	**90.92**	**$_{16}S^{32}$**	**95.0**	$_{20}Ca^{42}$	0.64
$_{10}Ne^{21}$	0.257	$_{16}S^{33}$	0.76	$_{20}Ca^{43}$	0.145
$_{10}Ne^{22}$	8.82	$_{16}S^{34}$	4.22	$_{20}Ca^{44}$	2.06
$_{11}Na^{23}$	**100**	$_{16}S^{36}$	0.014	$_{20}Ca^{46}$	0.0033
$_{12}Mg^{24}$	**78.7**	**$_{17}Cl^{35}$**	**75.53**	$_{20}Ca^{48}$	0.18
$_{12}Mg^{25}$	10.13	$_{17}Cl^{37}$	24.47		
$_{12}Mg^{26}$	11.17	$_{18}Ar^{36}$	0.337		
$_{13}Al^{27}$	**100**	$_{18}Ar^{38}$	0.063		

2. Model Development

Model development begins with the following simple set of rules:

(1) Except for Z=1, N in the abundant stable nucleus is equal to or greater than Z,

(2) Odd Z have a proton in the center of the structure,

(3) Even Z have a neutron(s) in the center of the structure,

(4) The nucleons are symmetrically arranged orthogonally and build proportionally along the 3 axes, and

(5) Protons are separated by neutrons.

Figure 1 shows the helium nuclide. Here, N=Z, and the protons are separated by two neutrons. Figure 2a shows a model of lithium. Having odd Z, a proton is placed in the center of the structure. The structure could be as shown in Figure 2b, which would explain why 7% of lithium nuclides have only three neutrons. Note: This article focuses on abundant nuclides with some reference to non-abundant nuclides.

Figure 1. Helium $_{2}\mathbf{He}^{4}$

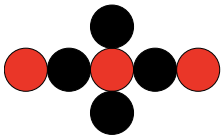

Figure 2a. Lithium $_{3}\mathbf{Li}^{7}$

Figure 2b. Lithium $_{3}\mathbf{Li}^{6}$

The next nuclide is beryllium. Given that Z is an even number, the center nucleon is a neutron as shown in Figure 3.

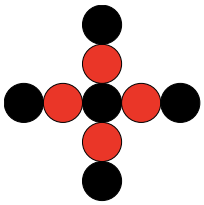

Figure 3. Beryllium $_{4}\mathbf{Be}^{9}$

The abundant isotope of boron is shown in Figure 4a. Nucleons are now building on the z-axis to give a three dimensional arrangement. A stable isotope of boron ($_{5}B^{10}$) has a significant percentage of abundance (~20%) and would have only one neutron on the z-axis. One possible explanation would be the structure shown in Figure 4b. This structures is physically symmetrical and abides within the rules for model development, however, a neutron missing on the z-axis makes the structure asymmetrical.

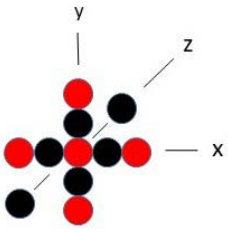

Figure 4a. Boron $_{5}\mathbf{B}^{11}$

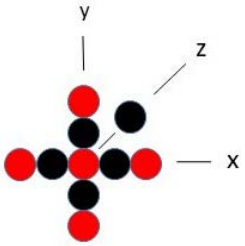

Figure 4b. Boron $_{5}\mathbf{B}^{10}$

The next nuclide is carbon. Its structure and its corresponding symbol is shown in Figure 5a, and this structure appears to be the base for developing structures for even Z=8 and beyond.

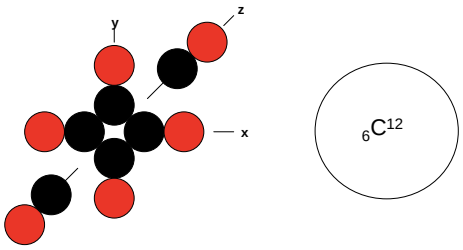

Figure 5a. Carbon $_{6}\mathbf{C}^{12}$ structure and corresponding symbol

Figure 5b represents the center for odd Z (Figure 5a with a proton in the center, designated by the letter P).

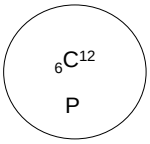

Figure 5b. Symbol for carbon structure with a proton in the center

Nitrogen is an aberration in the pattern. One would expect the model for nitrogen to be as shown in Figure 6a. However, this isotope only exists in an abundance of 0.37%. The most abundant isotope is nitrogen 14. Removing a neutron from the outer structure to make nitrogen 14 violates the rule of symmetry. However, similar to the non-abundant isotope of boron, by replacing one of the neutrons in the center of the structure with a proton as shown in Figure 6b, symmetry is maintained. The actual structure could still be that shown in Figure 6c. For other abundant, odd Z nuclides, this rule doesn't seem to be violated. Of the 265 stable nuclides, only 4 nuclides (Z=odd) have an odd number of neutrons. [2]

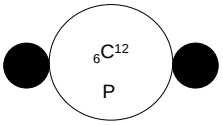

Figure 6a. Nitrogen $_{7}\mathbf{N}^{15}$

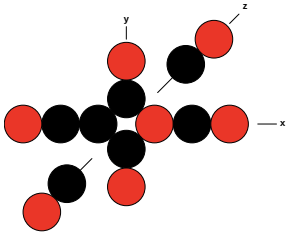

Figure 6b. Nitrogen $_{7}\mathbf{N}^{14}$

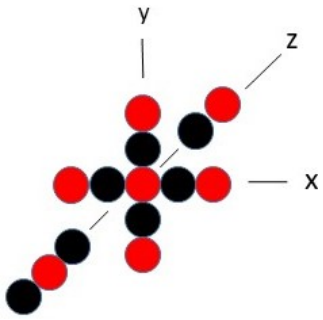

Figure 6c. Nitrogen $_{7}N^{14}$

The structures for Z = 8 through 19 are shown in the following figures. Note, upon moving from one structure to the next, a pattern develops which allows one to predict the next abundant isotope.

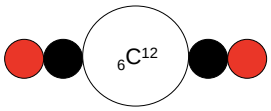

Figure 7. Oxygen $_{8}O^{16}$

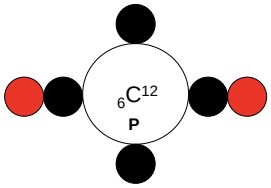

Figure 8. Fluorine $_{9}F^{19}$

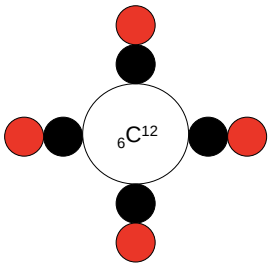

Figure 9. Neon $_{10}Ne^{20}$

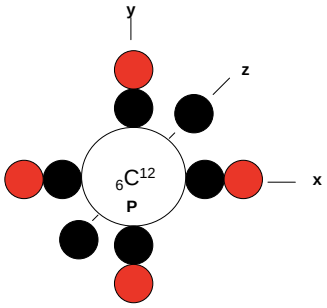

Figure 10. Sodium $_{11}Na^{23}$

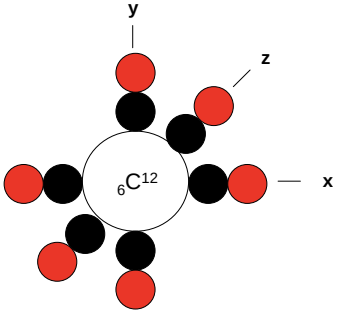

Figure 11. Magnesium $_{12}Mg^{24}$

To facilitate drawing the next set of models, Figure 11 is represented by the symbol in Figure 12 and becomes the new base for the next six abundant nuclides.

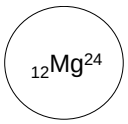

Figure 12. Symbol for Magnesium

The next set of figures are aluminum which is a magnesium model with a proton in the center and with two neutrons on the outer layer, followed by silicon through chlorine.

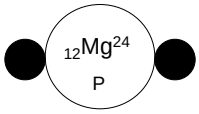

Figure 13. Aluminum $_{13}Al^{27}$

Figure 14. Silicon $_{14}Si^{28}$

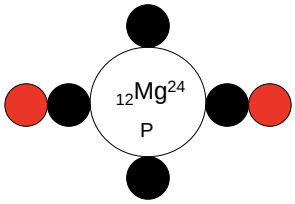

Figure 15. Phosphorous $_{15}P^{31}$

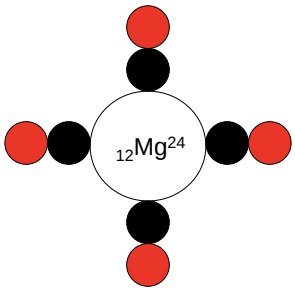

Figure 16. Sulfur $_{16}S^{32}$

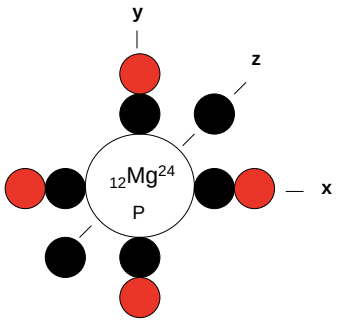

Figure 17. Chlorine $_{17}Cl^{35}$

The previous eight figures show a proportional development of nuclides in an orthogonal arrangement. From this point, as Z increases, there tends to be an increase in the number of neutrons. For example argon

($_{18}Ar^{40}$) has four extra neutrons (See Figure 18). The following two nuclides fall back into the normal pattern, but as Z increases, many of the nuclides require two, four, six or eight additional neutrons. The increase is in even numbers which maintain balance or a symmetrical arrangement. Knowledge of the types of forces and associated energy strengths within nucleons is needed to explain why extra neutrons are permitted or required, and why the isotopes vary in abundance to the degree that they exist.

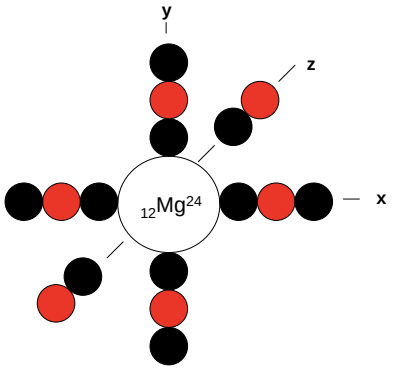

Figure 18. Argon $_{18}Ar^{40}$

The even nuclides have more isotopes than the odd nuclide. This may be explained by the fact that the structure for odd nucleons have a proton in the center, and that even nuclides could very well have one neutron added to the center for those nuclides with Z=6 and beyond. For example, placing a neutron in the center of carbon 12 would yield carbon 13. One percent of carbon exists as carbon 13. This would also explain why 0.037% of oxygen exists as oxygen 17. Adding two neutrons to the outer layer of oxygen 16 yields oxygen 18, which exists on the order of 0.204%. The probable reason for the low percentages is that the nucleonic forces are just inside the envelope of stability; i.e. they are pushing the threshold of instability.

To further validate this pattern, one could assume an electron orbiting arrangement on the orthogonal axis to see how well the pattern adapts to the Periodic Table. The horizontal rows of the table are called periods, according to their atomic numbers. Each vertical column in the Periodic Table makes up a related group of elements based on their chemical behavior. The following figures are proposed electron orbiting patterns associated with each element in a column. As the figures progress, one can see a common pattern.

Figure 19 shows the electron orbit pattern for the Group 1A alkali metals; lithium, sodium and potassium. For lithium, there is one electron not orbiting on one side and two electrons orbiting opposite each other on the other side. For sodium, there are four equally spaced electrons orbiting on each end of the x-axis and the same pattern as lithium on the y-axis. For potassium, there are four groups of electrons on the ends of the x and y axes with the lithium pattern on the x-axis. For the orbits to mesh with each other, think of four gears at right angles meshing with each other, and that the electrons are connected to the axes by energy strings, perhaps made up of photons. In order to mesh properly, there can only be a maximum of four electrons orbiting on the same plane. The group of four on each end of the x-axis rotate in the opposite direction of each other, and the same for those on the y-axis. The two electrons on the left side of the x-axis orbit in the same direction as the group of four next to it. For this to work, electrons cannot be orbiting on the z-axis.

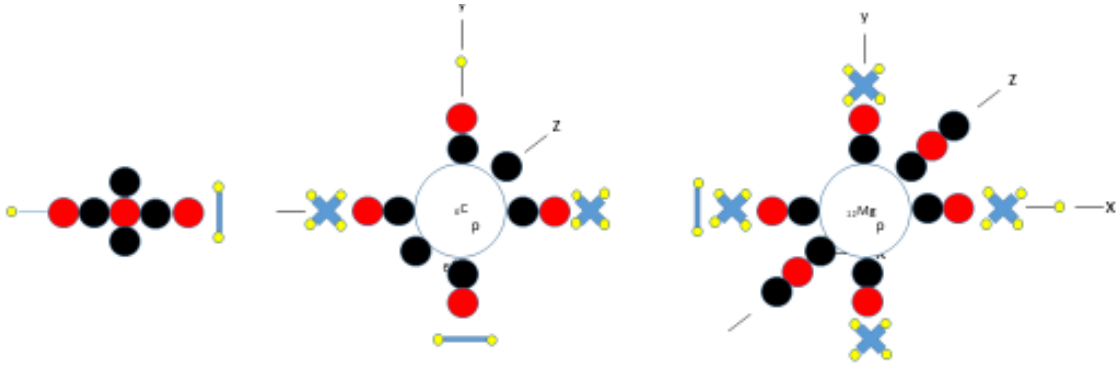

Figure 19. Electron Spin Pattern for $_{3}Li$, $_{11}Na$ and $_{19}K$

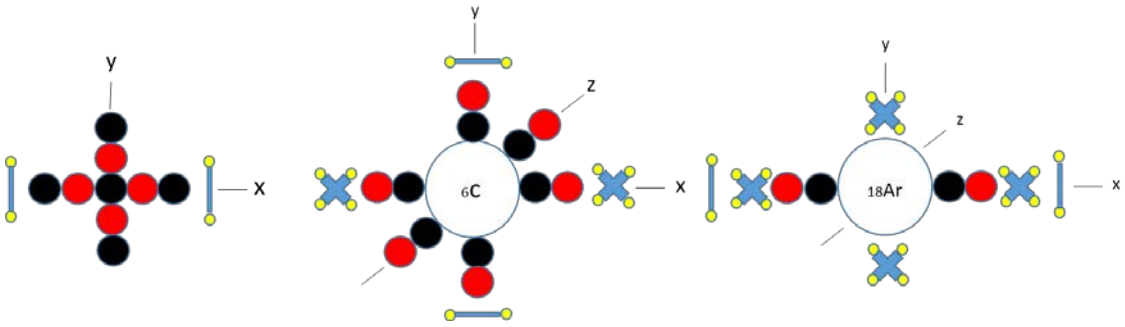

Figure 20. Electron Spin Patterns for $_{4}Be$, $_{12}$ Mg, and $_{20}Ca$

Figure 20 shows the electron orbiting pattern for the Group 2A alkaline earth metals; beryllium, magnesium, and calcium. In each element, there are two groups of two electrons spinning opposite of each other.

Notice the commonality of two pairs of electrons orbiting opposite each other on the same axes, and also notice the orbiting patterns are building symmetrically as one progresses from the lighter to the heavier elements.

Moving across Periods 2 and 3, Figure 21 and Figure 22 show comparisons for Groups 3A (boron and aluminum) and 4A (carbon and silicon). Again, note the similarities between the two elements in each Group and then note the symmetrical buildup in each of Figure 21 and Figure 22.

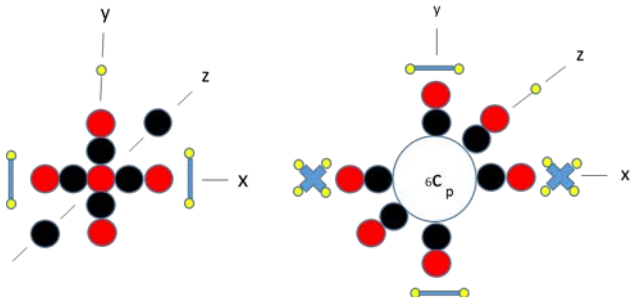

Figure 21. Electron Orbit Patterns for Group 3A Elements $_5$B and $_{13}$Al

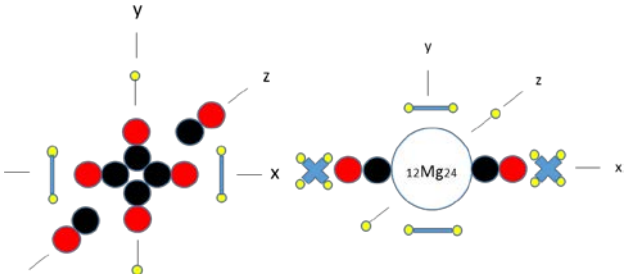

Figure 22. Electron Orbit Patterns for Group 4A Elements $_6$C and $_{14}$Si

Moving on to the inert (or noble) gases, helium through argon, the symmetrical arrangements shown in Figure 23 may explain why these elements are inert.

The configurations for other classes/periods seem to be related to the number of neutrons and how they are oriented along the three axis. For example, the configuration of the next inert element (Krypton 36) could very well be four more groups of four on the x and y axis' and two electrons in series on each end of the z-axis.

The rotating electron pairs or quadrupoles create a magnetic field. The interaction of these fields create a unique magnetic signature for each element and hints at playing a prime role in combining elements to form molecules. Given the symmetrical arrangement of nucleons and orbiting electrons of the inert gases, the magnetic fields would cancel each other. That may be why they don't combine with other elements.

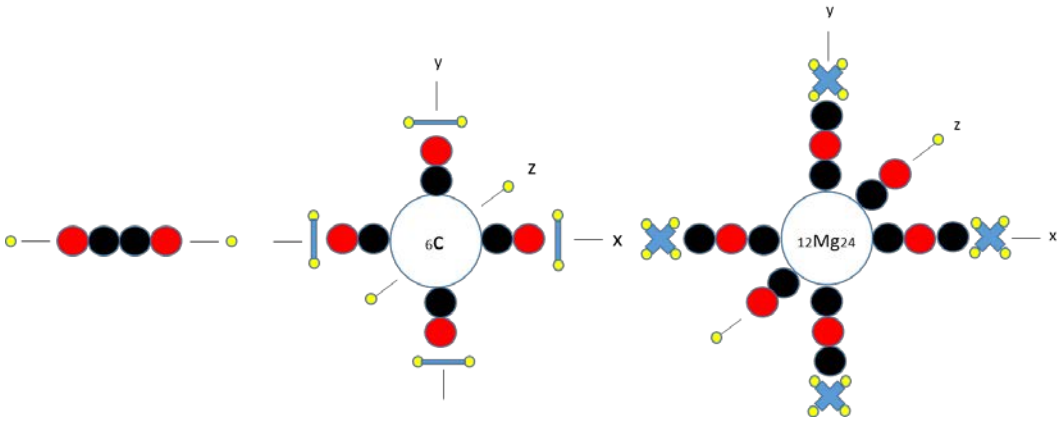

Figure 23. Electron Spin Patterns for the inert gases, Helium, Neon, and Argon

3. Summary

This mechanical model approach for stable atomic nuclei is based on an orthogonal arrangement of protons and neutrons. It is based on pattern recognition and lends support to nuclear pairing, shell modeling (without a gap), and symmetry concepts of nuclear structure and does not support independent particle models where nucleons move in mean free paths within the nucleus. Knowledge of the types of forces and associated energy levels within nucleons is needed to explain why extra neutrons are permitted or required in the heavier nuclides and why isotopes vary in abundance to the degree that they exist. This approach is further validated by electron orbiting patterns that group elements in accordance to the Periodic Table using the orthogonal arrangements and opens the door for pushing physics beyond the standard mode (BSM).

References

[1] Enge, Harald; "Introduction to Nuclear Physics", Addison-Wesley Publishing Co, Inc. 1966, Pages 529-531.

[2] Page 109