

Infinite Particle Physics

Chapter 5 - The Structures Of Single-Plane Nuclei

In the previous chapter, I demonstrated that IPP's five-plane concept of nuclear structures works nicely for all the elements of the periodic table above $Z = 36$, Krypton, and is rather compelling for the group of elements above $Z = 26$, Iron. In this chapter, I explore the structures of the single-plane elements from $Z = 1$, Hydrogen, up to the point of transition into five-plane structures, and move through this transition region up to $Z = 28$, Nickel.

Single-plane structures are, unexpectedly, more complex than five-plane structures, because, from $Z = 4$ upward, they tend to contain perimeter alpha groups (i.e. groups of $2p/2n$ in the two-state charge-exchange mode of the alpha particle) in some of their isotopes. In order to clarify this tendency, it will be necessary to look more broadly at the isotopes of each element. The definitive approach would be to show structures for all the isotopes of each element, but this gargantuan effort is clearly inappropriate until many other minds have made their creative contributions to this study. So let us make a modest start by choosing only *four* isotopes of each element. These will be:

- The lightest (as of 1985; some as of 1995)
- The most abundant (or the longest half-life)
- The second most abundant (or second longest half-life)
- The heaviest (as of 1985; some as of 1995)

If our structural ideas are on the right track, there should be clearly perceived build-up principles from the lightest to the heaviest isotope of each element, and smooth patterns of incremental changes in structures with increasing atomic number. We should, of course, expect substantial changes, when a proton adds to a nuclide structure whose rows and columns are completely filled, which may lead to alternative arrangements of rows and columns.

Now, Some Details Needed To Understand IPP's Schematics

For your convenience, I repeat below the symbols I used in the previous chapters to show the structures of both single-plane and five-plane nuclide structures. The five-plane schematics, of course, should be interpreted as aerial views, in which the various planes comprising the nucleus are superimposed, one atop another. You will notice that I occasionally characterize the spin of single-plane structures by using *unpaired nucleon* symbols; all the other nucleons in these schematics are assumed to be paired:

Meaning Of Symbols Used In This Chapter

■ = 3 layers of protons (layers #1,#3,#5)
 □ = 3 layers of neutrons (layers #1,#3,#5)
 P = two layers of protons (layers #1 & #3)
 N = two layers of neutrons (layers #1 & #3)
 p = one layer of protons (layer #3 in 5-plane)
 n = one layer of neutron (layer #3 in 5-plane)
 ● = unpaired proton
 ⊙ = unpaired neutron
 > = dual ip neutrons, left-slant (layers #2 & #4)
 < = dual ip neutrons, right-slant (layers #2 & #4)
 > = single ip neutron, left-slant (layer #2)
 < = single ip neutron, right-slant (layer #2)
 α = proton/neutron in alpha charge-exchange mode
 (I give protons & neutrons the same symbol in this mode because they alternate identities too fast to correlate with surrounding six-state nucleons).


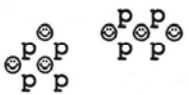
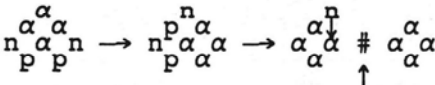
The Format Used In This Chapter

In order to make the most compact presentation of these numerous schematics, I do not identify the nuclide data which appears immediately below the title of each isotope, except for the first element, Hydrogen. You should study this list carefully, to fix these categories in your mind. You will find that the data given may vary according to their usefulness in clarifying our choices among a number of structural alternatives for a particular element. The properties which are most helpful are: percent abundance or half-life, decay modes, and nuclear spin. When the mass-deficit for a particular isotope is not given with a schematic, you can often, but not always, find it in Table 5-1, at the end of this chapter.

The Category Of Isotope For Each Element

Lightest Isotope	Most Abundant	2nd Most Abundant	Heaviest Isotope
Isotope	1H1	1H2	1H3
% abundance:	99.985%	0.015%	12.3y β-
(or half-life & decay mode):		→ → → → → → → → → ↑	
Spin, Parity (h/2π)±:	1/2	1+	1/2+
Mass Deficit (MeV):	0	-2.22	-8.48
Structure:	p	⊙ ●	n n
	2He4	2He3	2He8
	99.99986%	0.00014%	.12s β- n
	0+	1/2+	0+
	-28.30	-7.72	-31.42
	α α	⊙ p p	n n n n p n
	3Li5	3Li7	3Li6
	?	92.5%	7.5%
	3/2-	3/2+	1+
	-26.33	-39.25	-32.00
	● ● ●	n n n n	⊙ p n p n
			0.18s β- n2α
			3/2-
			-45.34
			n n n n n n

The isotopes of the next element, Beryllium, have such a curious sequence of binding energies, that they provide a good test of IPP's structural concepts. So, let's look at all of them. We begin, here, with Be 6, 7, & 8; I continue with Be9→14 on page 5-7:

4Be6	4Be7	4Be8 → → → → 2α	
β+	53.3d EC	.067fs. 2α	stable
?	3/2-	0+	0+
-26.92	-37.60	-56.50	-56.60
			
			2 x 0.046 MeV

Notice that I have shown two structures for Be7, both having the same number of bonds (6pb + 8db). The right-hand structure seems more plausible, but only the left-hand one, being asymmetric, could have the minus parity that experiments show.

4Be8: Evidence For Alpha-Type Charge-Exchanges In Nuclei?

You will notice that the binding energy of Beryllium 8 is -18.90 MeV greater than Be7. This difference is much too large to be attributed to the bonds which adding the extra neutron creates (1pb+2db ≈ -6.9 MeV). Here is clear evidence that adding this extra neutron permits the formation of an alpha-type two-state charge-exchange among four of the eight nucleons of Be8. This change in charge-exchange mode causes these four nucleons (indicated by "α" symbols) to lose 15.47 MeV of mass-energy (see p. 3-11).

The other four nucleons remain in their normal six-state charge-exchange, but *only very briefly*, since this structure almost instantaneously (0.067 fs) breaks apart into two alpha particles. I show a plausible sequence of structural changes which might permit a second alpha to form, with arrows in the 4Be8 schematic, above.

How The 4Be8 Structure Decays → 2-α

This decay begins with a shift of the alpha charge-exchange to an asymmetrical location, as I show in the second schematic. You should perceive that this shift doesn't require any of the nucleons to exchange places; the only thing that shifts is the *locus* of the alpha two-state charge-exchange. Notice that this shift causes the alpha group to be bound to the other nucleons with one less diagonal bond. Notice, also, that three of the non-alpha nucleons are now in a Helium 3 arrangement. Hence, it requires only for the top neutron to move down, and bind to the Helium 3 u-notch, to put these four nucleons into an alpha configuration.

Why the alpha group increases its spacing during a grain-boundary transit: The alpha-group's asymmetrical relationship in the second structure *increases the repulsion* between the alpha group and the normal nucleons, because only one neutron offsets the inherent repulsion between the alpha group and two protons contacting it. This increased repulsion may be sufficient to cause the needed separation during a particularly disruptive grain-boundary transit, thereby allowing the top neutron to migrate to the helium 3 u-notch to form the 2nd alpha particle.

Why the two alphas separate: When the second alpha forms, the two alphas are then bound with only a single paraxial bond, and this is always an odd-spaced bond, because the outer c-voids of an alpha particle remain always positive during the two-state charge-exchange (see Fig. 3-10). This paraxial bond will be even weaker than that of the

rho(770) (see pg. 2-26), because the bond spacing will be between 9ü defect-pairs (on the average), rather than the rho's 10ü defects-pairs (also, on the average). Since this paraxial bond between the alphas must move by cardinal translation, we can guess that it will have these parameters:

$$(9[9]9 + 9[11]9)/2 \approx (-2.48 + -1.47) \approx -1.98 \text{ MeV}$$

This pb compares to the rho's pb:

$$(10[7]10 + 10[6]10)/2 \approx (-7.49 + -3.14) \approx -5.32 \text{ MeV}$$

We will expect the alphas' paraxial bond to be even less stable in translation through the lattice, than the rho's, so it is reasonable to expect it to fracture even quicker than the rho's bond, whose half-life is in the vicinity of 10^{-23} seconds. Once the paraxial bond breaks, it is easy to see why there is enough excess undedicated shrinkage to cause the two alphas to separate. Beryllium 8's binding energy is -56.50 MeV, while the two separated alpha have a combined mass-deficit of $-28.30 \times 2 = -56.60$; therefore the undedicated shrinkage available for separation momentum is:

$$-56.50 - (-28.30 \times 2) = +0.10 \text{ MeV of undedicated shrinkage}$$

The half-life of $4\text{Be}8$ (0.067 ps) is clearly set almost entirely by the time required to intersect a grain-boundary of sufficient destabilizing capability, rather than by the much shorter half life of the subsequent breaking of the pb holding the two alphas together.

Other Evidence Of Alpha Charge-Exchange-Groups In Nuclides

If you will look at Table 5-1 at the end of this chapter, you will notice that, following Beryllium, every element exhibits regions in its isotopes which exhibit large incremental mass-deficit values. These large incremental values are a tell-tale of alpha formation, because they cannot possibly be the result of a neutron bonding to the periphery of the nuclear core. A few examples make this necessity for alpha formation clear. Suppose we calculate what the binding energy of this added neutron would be, if the nuclear core lacked the expected number of alphas groups. I give three examples, below:

	4Be7→4Be8	6C9→6C10	8O13→8O14
	◊ = location of added n		
	$\begin{matrix} p & p & & \\ n & n & n & \\ p & \diamond & p & \end{matrix}$	$\begin{matrix} p & p & p & \\ p & n & p & \\ p & n & \diamond & p & \end{matrix}$	$\begin{matrix} p & p & p & p & \\ p & n & p & n & p & \\ p & n & p & \diamond & p & \end{matrix}$
bonds	1pb, 2db	2pb, 2db	2pb, 2db
	If MD of pb ≈ -2.5 MeV & db ≈ -2.2 MeV, then:		
IMD ≈	-6.9 MeV	-9.4 MeV	-9.4 MeV

These are obviously crude incremental mass-deficit (IMD) figures, and could vary an MeV or two, depending upon whether nucleon pairing, or unpairing, occurs as a result of the neutron addition; but these values are obviously far removed from the 17 to 21 MeV incremental mass-deficit (IMD) values found experimentally. These large changes in IMD can be explained only if we presume that two protons & two neutrons in the nuclear structure adopt the alpha particle charge-exchange cycle.

We can satisfy ourselves that this is true by a simple calculation. If we assume that the added neutron becomes incorporated in the newly created alpha group, we can calculate the resulting IMD by subtracting one of these above calculated values from the mass-deficit of an alpha particle (-28.30 MeV):

MD Increase: α - calc. MD	Experimental Data
-28.30 - (-6.9) = -21.4 Mev	C9→C10 = -21.27
-28.30 - (-9.4) = -18.9 Mev	Be7→Be8 = -18.90
-28.30 - (-11.6) = -16.7 Mev	Ne19→Ne20 = -16.87

We must not get too excited by the rather close correlation with these experimental values. If we chose other isotopes, we might find rather large discrepancies between calculation and experiment, because there is almost a continuum of IMD values too large for simple bonds (i.e. from -11.6 to 21.27 MeV) in Table 5-1, at the end of this chapter. Any of these 1985 values might point to α -group formation, and give us hints of how many of these α -groups may be present. Yet these data tell us nothing about structures. If we want to discern what nucleon cluster geometries *promote* (or *inhibit*) the formation of alpha charge-exchange groups, or *result in the expulsion* of an alpha particle, we must use other clues:

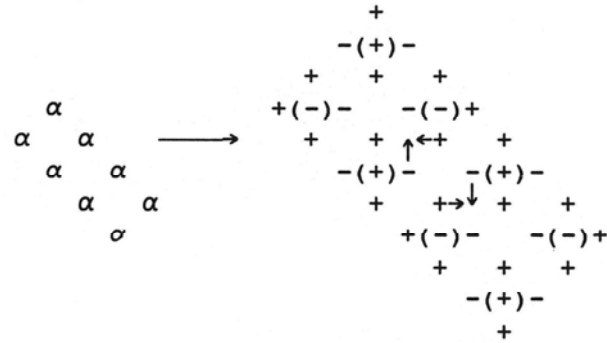
Fitting Alpha Groups Into Nuclide Structures

We have learned certain things about alpha particles which will help us decide where alpha groups will locate in nucleon clusters.

Alpha groups cannot bond strongly to each other: We perceive that this is true, if we think carefully about the *external* bonding implications of the in-and-out movement implicit in the *offset* kaon-type charge-exchanges of the top/bottom & edge defect-pairs. As I have explained on Page 3-11, the alpha's *internal* diagonal bonds (the ring bonds) depend upon *all four top/bottom defect-pairs moving in-and-out together*. Because of this requirement, all four *edge* defect-pairs will move *out-and-in together*, i.e. they move *out*, when the top/bottom defect-pairs move *in*, and vice-versa.

Now let's think about the way these opposite in-and-out movements affect the bonds between adjacent alpha particles, as shown in Fig. 5-1, below:

Fig. 5-1 Misaligned pb's Between Adjacent Alpha Groups



What I have assumed, in Fig. 5-1, is that the two adjacent alpha groups have synchronized their two-state charge-exchanges so as to maximize the diagonal bonds between the ring-bonded defect-pairs (i.e. so that these defect-pairs "breathe" in-and-out together). What this choice does is to cause the *two paraxial bonds* between the two alphas *to have their pairing axes offset $\pm 1\bar{u}$ in both charge-exchange states*, thereby weakening these bonds.

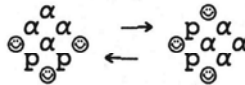
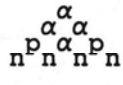




Obviously, *out-of-phase charge-exchanges* between the two alphas could allow these paraxial bonds to align, but this option would cause the diagonal bonds to be offset, and weakened. What this tells us is that:

Multiple alpha groups will prefer to be joined together through the agency of intermediate nucleons of the normal six-state charge-exchange type: The reason: Six-state nucleons have the ability to offset their component pairing axes to accommodate to those of adjacent nucleons (as we found in Chapter 3).

Alpha groups will tend to locate on the periphery of a planar nucleon cluster: You will see that a central location of an alpha group would require the whole particle "to breathe in and out", as it translates through the lattice, and this may be disruptive to the bonds of non-alpha nucleons surrounding this alpha group. This potential for disruptive influence suggests that alpha groups will site only on the cluster's perimeter.

Peripheral alpha groups will tend to weaken the bonds of "normal" nucleons in a cluster: The reason: *An alpha particle is not square!* Notice, in the alpha particle drawing of Fig. 3-10, p. 3-11, that the width and length dimensions of the alpha particle differ by $2\bar{u}$ ($27\bar{u} \times 29\bar{u}$). It is obvious that the long dimension may be in either orthogonal direction, and may alternate between length & width, as the particle translates through the lattice. This length-width disparity may require the bond spacings of "normal" nucleons to breathe in-and-out as the cluster translates through the lattice. This will lessen the average bond mass-deficit. I will provide evidence of this, when we reach the Neon isotopes.

Now, Some Comments About Beryllium Isotopes 9 → 14

4Be9	4Be10	4Be11
100%	1.6e6y β-	14s β- β-/α
3/2-	0+	1/2+
-58.17	-64.98	-65.48
		
4Be12	4Be13	4Be14
β-	β-	β-
0-	3/2+	2+
-68.65	-68.14	-69.99
		

4Be9: Trying to add a neutron to Be8 to produce Be9 is a sure formula for failure, because of the exceedingly short half-life of Be8. Also, Be9 can't be formed via the β⁻ decay of Boron 9, because B9 decays, instead, p/2α. Hence, Be9 can only be formed by deuteride addition to 3Li7, which may account for its cosmic rarity.

The stability of Be9 may be due to its perfect symmetry, which assures that the locus of the alpha-type charge-exchange may move to any of the four quadrants without altering the geometry of its relationship to the other five nucleons. However, the small incremental mass-deficit (-1.67 MeV) resulting from the bonding of an unpaired neutron to my suggested structure for Be8 is somewhat surprising, in view of the larger mass-deficit consequences of neutron addition (≈ 6.9 MeV) we saw on the preceding page.

Of course, adding the extra neutron to the Be8 structure would interfere with the pairing of the two non-alpha Be8 neutrons, but this would only result in about 1 MeV lesser mass deficit. So, how do we account for the disappearance of another 4.2 MeV of mass deficit?

I would suggest that this loss results from the "stretching" of the average bond spacings between the "normal" nucleons and the inner nucleon of the alpha group, as the particle moves through the lattice. If we imagine the long & short axes of the alpha group switching direction with each lattice translation (i.e. moving by cardinal translation), then the "normal" nucleons must also move by cardinal translation, being symmetrically positioned relative the alpha group. This mode of translation causes the paraxial bonds to alternate between two values (say 9ü→11ü), which will force the diagonal bonds also to alternate (say between 9ü/ & 10ü/). These alterations should reduce the average bond mass-deficits sufficient to account for the small change in MD between Be8 & Be9.

4Be10: When a neutron is added to Be9, the two protons become paraxially bonded to the inner alpha nucleon, rather than the two neutrons of Be9. We infer this, because this arrangement is the only one which produces a structure with bi-lateral symmetry, thereby accounting for the observed spin of 0+.

4Be11: Notice, also, that the extra neutron of Be11 seems to quench alpha formation, which we can infer by the small incremental mass-deficit of -0.50 MeV:

4Be12, 13, 14: As more neutrons are added to Be11, there are only small increases in incremental binding mass-deficit. If you look at my proposed structures for these isotopes, you will see that each neutron addition *decreases* the number of *paired* nucleons, substantially so for Be13. These pairings, of course, reduce total IMD.

An Important Caveat

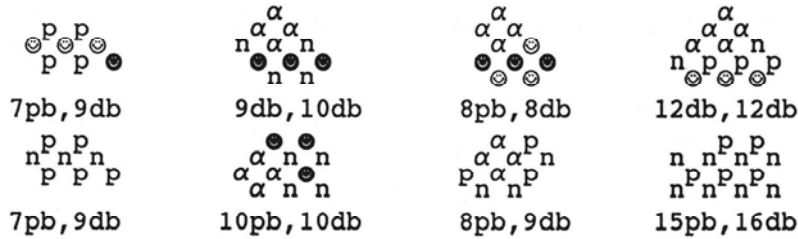
Now, having sensitized ourselves to the need to make our structures conform to the large incremental mass-deficits scattered through Table 5-1, we will proceed. Let me challenge you, again, to think along with me, because the structures in this chapter are just my best guesses, unverified by accurate mass-deficit calculations. You should expect many of these guesses not to survive the scrutiny of future IPP theorists, who will tackle these problems with much better analytical tools.

Another Gestalt Useful In Ferreting-Out Nuclide Structures

Protons and neutrons are mobile in alpha particles!: It is important to recall that an alpha-type charge-exchange switches the location of proton & neutron "entities" with *each* charge-exchange, whereas clusters of nucleons in the normal six-state charge-exchange cycle can't interchange p/n identities oftener than *every sixth* charge-exchange, and *may never* switch identities in some settings. Since there is no possibility of normal nucleons synchronizing their inter-nucleon charge-exchanges with alpha-group nucleons, we have no reason to think about the location of proton and neutron "identities" in the alpha groups (as our alpha symbol, "α", suggests). We can infer from this that the bonding between alpha groups and adjacent nucleons is not affected by interchanging proton and neutron locations of these "normal" six-state-charge-exchange nucleons. I used this insight to justify alternating neutron & proton locations between Be9 & Be10.

Some more examples: For B11, 10, & 13 below, I show three alpha arrangements relative to the "normal" nucleons. Let's look carefully to see which structures seem more plausible:

5B8	5B11	5B10	5B13
.77s β+/2α	80.2%	19.8%	.02s β-, β-/n
2+	3/2-	3+	3/2-
-37.74	-76.21	-64.75	-84.45
$\begin{matrix} n & p & p & n \\ p & p & p & \end{matrix}$	$\begin{matrix} \alpha & \alpha & n \\ p & \alpha & p & p \\ n & n & n & \end{matrix}$	$\begin{matrix} \alpha & \alpha \\ p & \alpha & p & p \\ n & n & n & \end{matrix}$	$\begin{matrix} n & \alpha & \alpha & n \\ n & \alpha & n & n \\ n & n & n & n \end{matrix}$
Total Bonds (excluding internal α-bonds)			
7pb, 9db	9pb, 10db	7pb, 8db	12pb, 12db



5B11: You will see, above, that I have used the *unpaired* nucleon symbols (each indicating a spin 1/2 contribution) to highlight the structures I consider most plausible. Notice that I have rejected the lower structure, with the strongest bonding, because, here, the alpha group is too much imbedded within the other nucleons to allow a two-state α charge-exchange to take place.

Let's make a rough calculation of the mass of the middle structure of 5B11, to see whether my choice makes sense. We can do this by summing the mass-deficits of these indicated bonds, adding the α mass-deficit of -28.30 MeV, and then adding -1 MeV each for the additional bonding due to pairing of 4 nucleons:

$$-28.30 + 9pb \cdot -2.5 + 10db \cdot -2.2 + 2pr \cdot -1 \approx -74.8 \text{ vs. } -76.21 \text{ MeV}$$

This calculation is reasonably close, being 1.4 MeV too small.

5B13: The two modes of decay of B13 suggest that its structure is a "resonance" alternation between two different nucleon arrangements (i.e. between the middle structure and the bottom one). My perception is that the lower structure, with its "out-of-place" neutron in the second row up, should decay β^- , while the upper structure may lose a neutron following β^- decay of the left neutron in the lower row, because of the substantial reshuffling which its change to a proton will provoke.

Carbon – Additional Examples Of p's And n's Switching Places

The Carbon isotopes are a challenge, because we need to understand why both C12 & C13 are stable, while C14 is not, though possessing a rather long half-life. Also, the incremental mass deficit data suggest that that these three isotopes have *two* alpha groups. The key to understanding this is, again, perceiving that the non-alpha protons can site in different relationships relative to the two α -groups. Below are three arrangements of these two alpha groups for C12, two for C13 & 14. Let us try to discover which ones appear to be consistent with the experimental incremental mass deficits:

6C9	6C12	6C13	6C14	6C16
13s $\beta^+, p, 2\alpha$	98.90%	1.10%	5730y β^-	.75s β^-, n
?	0+	1/2-	0+	?
-39.04	-92.16	-97.10	-105.29	-110.75
$\begin{array}{c} \textcircled{\ominus} \text{p} \text{p} \text{p} \text{p} \\ \text{p} \text{p} \text{p} \end{array}$	$\begin{array}{c} \alpha \alpha \\ \text{p} \alpha \\ \text{p} \text{n} \text{n} \\ \text{p} \alpha \\ \alpha \end{array}$	$\begin{array}{c} \alpha \alpha \\ \textcircled{\ominus} \text{p} \alpha \\ \text{p} \text{n} \text{n} \\ \text{p} \alpha \\ \alpha \end{array}$	$\begin{array}{c} \alpha \alpha \\ \text{n} \alpha \text{n} \\ \text{n} \alpha \text{n} \\ \text{n} \alpha \text{n} \\ \alpha \end{array}$	$\begin{array}{c} \text{n} \text{n} \text{n} \\ \text{p} \text{p} \text{p} \\ \text{n} \text{n} \text{n} \\ \text{n} \alpha \text{n} \\ \alpha \end{array}$
	9pb, 8db	10pb, 10db	12pb, 12db	
6c12	6c12	6c13	6c14	
$\begin{array}{c} \alpha \alpha \alpha \alpha \\ \alpha \text{p} \alpha \\ \text{n} \text{n} \\ \text{p} \end{array}$	$\begin{array}{c} \alpha \alpha \text{n} \\ \alpha \text{p} \text{p} \alpha \\ \text{n} \alpha \alpha \end{array}$	$\begin{array}{c} \alpha \alpha \text{n} \\ \textcircled{\ominus} \text{p} \text{p} \alpha \\ \text{n} \alpha \alpha \end{array}$	$\begin{array}{c} \alpha \alpha \text{n} \alpha \\ \alpha \text{p} \text{p} \alpha \\ \text{n} \text{n} \text{n} \end{array}$	
7pb, 8db	6pb, 6db	7pb, 8db	10pb, 10db	

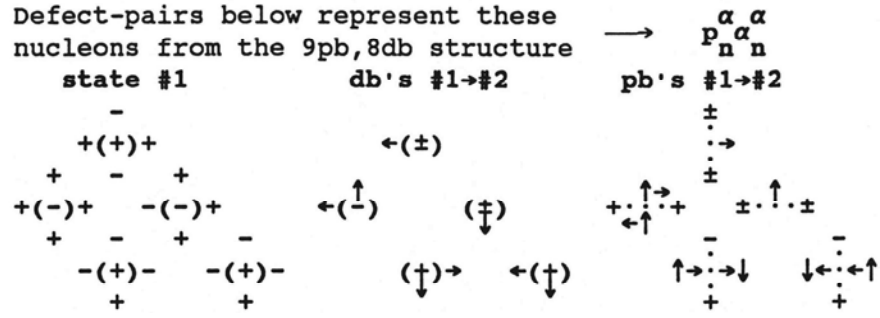
For the structures containing alpha groups, I indicate the numbers of inter-nucleon bonds, *excluding* the internal alpha bonds. It seems clear that the top structures, having larger total bonds, should be our choices, provided the strengths of the bonds are roughly the same for the various nucleon arrangements.

I wish I could validate these top structures with bond calculations, but this would constitute a very lengthy detour from my main objective in this chapter, which is just to show the complexities which come with including alpha groups in single-plane nuclides. Let's take a brief look at the upper structure of 6C12 with 9pb, 8db to show the underlying difficulties which must be confronted in making these mass-deficit calculations.

Since this structure is symmetrical about a horizontal plane through its center, we can see these difficulties by looking at just a *portion* of upper half of this structure, namely, the bonds between the lower three α 's and the adjacent proton and two neutrons (I have highlighted these six nucleons, above). These bonds between "normal" nucleons and α -nucleons must accommodate to the changing locations of the α 's defect-pairs between the two states of the α 's charge-exchange cycle. This accommodation requires that the "normal" nucleons adopt an offset mode of charge-exchange to maintain bond alignment between their participating defect-pairs and the shifting defect-pairs of the α -nucleons. I show these "normal" defect-pair shifts in Fig. 5-2, below.

The basic problem in diagramming these shifts is that the *ring-bond* defect-pairs in an alpha group shift *in-and out* while the α "notch" defect-pairs shift *out-and-in*, as I showed you, you will recall, in Fig. 5-1. I get around this confusion, below, by showing bonds between these defect-pairs in separate diagrams, labeled "db's" (diagonal bonds between α ring-bond defect-pairs and "normal" nucleons ones) and "pb's" (paraxial bonds between the α -nucleons "notch" defect-pairs and the defect-pairs of "normal" nucleons).

Fig. 5-2 Changing Locations Of Defect-Pairs In 6C12 Bonds



Notice, above, that I have shown the α -nucleon defect-pairs with \pm charges, to indicate that their polarities alternate in the two-state charge-exchange cycle, and with arrows to indicate the direction of movement of these defect-pairs between state #1 and state #2. Pairs of orthogonal arrows attached to the "normal" nucleon defect-pairs are to suggest that these defect-pairs must move in face-diagonal directions to maintain their bond alignments with the shifting α -nucleon defect-pairs. I couldn't think of any way to show the varying c-void charges resulting from the six-state charge-exchanges of the "normal" nucleons, but, of course, these additional complexities are what make these alpha \rightarrow normal bonds so difficult to calculate.

I shall leave the pursuit of these bond complications to my successors, with their younger and nimbler minds. In the remainder of this chapter, my intent is simply to leave them a legacy of preliminary structural notions to stimulate their thinking.

I shall discontinue showing four isotopes of each element, feeling that this is more detail than is warranted at this elementary stage of our understanding of bond complexities. What I shall do is merely to show what I consider to be the most plausible single plane structures for just two isotopes – the most abundant, and the second most abundant (or, if there is only one stable isotope, the longest half-life isotope). We begin with nitrogen:

7N14	7N15	8O16	8O18
99.63%	0.37%	99.63%	0.20%
1+	1/2-	0+	0+
-104.66	-115.49	-127.62	-139.81
$\begin{matrix} \alpha & & & \\ \alpha & \alpha & & \\ n & \alpha & n & \\ p & \alpha & p & \\ & \alpha & & \\ & \alpha & & \end{matrix}$	$\begin{matrix} \alpha & & & \\ \alpha & \alpha & & \\ n & \alpha & n & \\ p & \alpha & p & \\ & \alpha & & \\ & \alpha & & \end{matrix}$	$\begin{matrix} \alpha & & \alpha & \\ \alpha & \alpha & p & \alpha \\ n & \alpha & n & \\ \alpha & & & \end{matrix}$	$\begin{matrix} \alpha & & \alpha & \\ \alpha & \alpha & p & \alpha \\ n & n & p & n \\ \alpha & & & \end{matrix}$
9F19	9F18	10Ne20	10Ne22
100%	110m β^+, EC	90.51%	9.22%
1/2+	1+	0+	0+
-147.80	-137.37	-160.65	-177.77
$\begin{matrix} \alpha & & & \\ \alpha & \alpha & & \\ p & \alpha & p & \\ n & n & n & n \\ & \alpha & & \\ & \alpha & & \end{matrix}$	$\begin{matrix} \alpha & & & \\ \alpha & \alpha & & \\ p & \alpha & p & \\ \alpha & n & n & \\ & \alpha & & \\ & \alpha & & \end{matrix}$	$\begin{matrix} \alpha & & \alpha & \\ \alpha & \alpha & p & \alpha \\ n & n & n & \\ \alpha & p & \alpha & \\ & \alpha & & \end{matrix}$	$\begin{matrix} \alpha & & \alpha & \\ \alpha & \alpha & p & \alpha \\ n & n & n & n \\ \alpha & p & \alpha & \\ & \alpha & & \end{matrix}$

We see again, below, that by interchanging the location of protons and neutrons for the odd-Z elements we can arrive at a plausible & perfectly symmetrical structure for the most abundant isotope of sodium, 11Na23; Na22 builds upon 10Ne21 structure:

11Na23	11Na22	12Mg24	12Mg26
100%	2.6y β^+ EC	78.99%	11.01%
3/2+	3+	0+	0+
-186.57	-174.15	-198.26	-216.68

Adding two proton & two neutrons to 11Na23 forms 13Al27. Notice the strong bonding of the center row, out-of-place neutrons of 13Al27 (3pb, 2db). This strong bonding, plus increased pairing, explains the rather large change in incremental mass-deficit between 13Al26 & 13Al27 (-13.05 Mev):

13Al27	13Al26	14Si28	14Si29
100%	7.2e5y β^+ EC	92.23%	4.67%
5/2+	5+	0+	1/2+
-224.95	-211.90	-236.54	-245.01

15P31	15P33	16S32	16S34
100%	25.3d β^-	95.02%	4.21%
1/2+	1/2+	0+	0+
-262.92	-280.96	-271.78	-291.84

Chlorine, 17Cl35, however, requires an inversion of proton & neutron locations to make a plausible structure. This structure also provides plausible addition sites of neutrons to form 17Cl37:

17Cl35	17Cl37	18Ar40	18Ar36
75.77%	24.23%	99.60%	0.34%
3/2+	3/2+	0+	0+
-298.21	-317.10	-343.81	-306.72

Notice that I have changed the location of the two central protons of 18Ar36 to top & bottom center in 18Ar40. What I have assumed is that neutrons will locate in the two notches of 18Ar36 and then be immediately replaced by proton "identities" through successive inter-nucleon charge-exchanges, creating a central four-neutron "island". The resulting structure would seem to be perfectly stable *and* neutron "saturated", so it would have no ability to add more stable neutrons.

19K39	19K41	20Ca40	20Ca44
93.26%	6.73%	96.94%	2.09%
3/2+	3/2+	0+	0+
-333.73	-351.62	-342.05	-380.97

add ☼ = 20Ca48 (0.187%, 0+, -415.99 MeV)

Although the single-plane structures seem to fit the Calcium isotopes reasonably well, there is a puzzle about 20Ca48:

- How can 20Ca48 be stable, when its neutrons ("☼") attach in proton locations?

Answer: perhaps inner protons migrate to the "☼" locations by inter-nucleon charge-exchanges, leaving excess neutrons in the particle center.

The astoundingly long half-life of 19K40 (0.0117%, 1.25e9 yr.) merits our investigation:

19K40			
precursor spin 2+ form	1.25e9 y. 4- form	β^- decay 7/2- form	β^+ , EC decay 2+ form

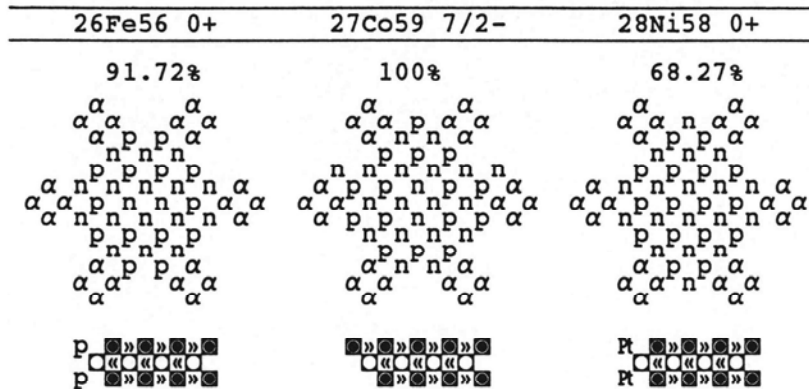
K40's long half-life could relate to the odd neutron translating by "entity" exchange into a sequestered and strongly bound location (shown in the second diagram, above). This structure may be unconditionally stable, and may decay only when grain-boundary transits produce the various nucleon rearrangements shown.

21Sc45	21Sc46	22Ti48	22Ti46
100%	84 d. β^-	73.8%	7.0%
7/2-	4+	0+	0+
-387.85	-396.61	-418.70	-398.20

Notice that the extra proton in the middle row of 21Sc45 still doesn't permit the formation of a fifth alpha group, because this group would be too much embedded. This is true, also, for Titanium, with six protons in the middle row. However when a seventh is added, as with Vanadium, below, an extra alpha group could possibly form, although, at this degree of complexity, these single plane forms aren't nearly as appealing as the five-plane forms, below them.

23V51 7/2-	24Cr52 0+	25Mn55 5/2-
97.75%	82.79%	100%

The five-plane forms, above, seem more plausible for the most abundant isotopes of Vanadium, Chromium, and Manganese, and this is also true for Iron, Cobalt, & Nickel, although the single-plane form of Iron, 26Fe56, has pleasing symmetry:



The Single-Plane to Five-Plane Transition Point

When I examine the single-plane and five-plane structures for the most abundant isotope of these last eight elements, $Z = 21 \rightarrow 28$, I am modestly persuaded that the transition to five-plane forms begins with $Z = 21$ (Scandium). This conclusion appears to be supported by the incremental mass-deficit data, which I have graphed, on the next page, for the elements, $Z = 19$ (K) to $Z = 32$ (Ge). What we see in these graphs is that the most abundant isotope for potassium (K) and Calcium (Ca) occurs *before* the dramatic decline in incremental mass-deficit, whereas, from Scandium (Sc) on, the most abundant isotope appears *after* this dramatic decline. This suggests to me that this dramatic decline is, itself, the indicator of the transition to five-plane structures; hence, even the higher isotopes of Calcium & Potassium may be five-plane structures.

We Move on to Other Things

I hope these three chapters on nuclear structures have opened new vistas for those of you who yearn to understand the structural propensities of nucleons. I realize that I have not offered solid proof of the validity of my suggested structures. Please think of them as just a hazy beginning, awaiting the ability of the physics community to make accurate mass-deficit calculations of all the inter-nucleon bonds in these dynamic, "breathing" structures. Let us hope that some of you will be motivated to dig deeply into these matters.

Now, let us move on to another interesting facet of my ether approach to physics – the ability to show that decay of particles is *induced by destabilizing agents*, rather than being "spontaneous"!