

The Aromatic Nature of All π -Bonds, The Isolated Single π -Bond Being the Trivial One, $N=0$, In The $4n+2$ Rule for Number of Participating Carbons/ π -Electrons

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ABSTRACT

This paper develops a novel theory of atomic and molecular orbitals grounded in a broader quantum physics framework articulated across four prior volumes. The central hypothesis posits that atomic orbitals are fixed, geometrically defined structures—unlike the probabilistic “fuzzy” models arising from the unsolved radial part of the Schrödinger equation. While the angular component of the wavefunction $\psi(\theta, \phi)$ has been successfully derived and utilized to classify orbital types (s- and p-orbitals), this work emphasizes a complementary geometric interpretation. Molecular orbitals, in this theory, are formed by the direct “touching” of atomic orbitals, with bonding permitted only when the change in angular momentum quantum number satisfies $\Delta l = \pm 1$. Electrons traverse the surfaces of these orbitals at the speed of light ($v=c$). This requirement results in a characteristic bonding sequence of p–s–p–s... in molecular systems. An s-orbit, being devoid of angular momentum, causes electrons to reverse direction at specific nodes, giving rise to oscillatory angular behavior. This contrasts with p-orbitals, where motion involves rotation about the z-axis. These principles set the foundation for a re-examination of π -bonding and aromaticity, suggesting that even an isolated double bond constitutes a minimal aromatic system ($n = 0$), governed by dynamic electron resonance and structural symmetry. This work builds on the author’s previous theoretical volumes and seeks to redefine core concepts in chemical bonding and molecular structure.

Keywords: Aromaticity; π -bond; Quantum orbital theory; $\Delta l = \pm 1$ rule.

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INTRODUCTION TO THE $\Delta l = \pm 1$ RULE IN BOND FORMATION

We have a theory whereupon adjacent atoms, exchanging electrons, must be in such states of their respective valence atomic orbitals such that they differ by $\Delta l = \pm 1$. In this situation, we describe the passage of electrons being exchanged between the two atoms as a molecular orbital. Now it made a lot of sense to propose that σ -bonding, (single bond), versus π -bonding (double bond), is facilitated in the following manner.



Figure 1: In σ -bonding, the s- and p-orbitals touch each other in one location. In π -bonding, the s- and p-orbitals touch each other in two locations. With sigma, it is easy to give a coherent designation of arrows representing the electron direction, but with pi, one finds you get electrons running into each other.

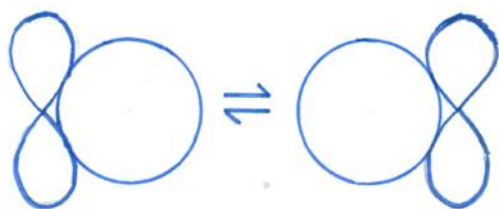


Figure 2: By analogy to aromatic systems, where bonds rapidly oscillate between single and double, and because we couldn't justify, in a π -bond, the arbitrary designation of one atom having the p-orbit, and the other the s-orbit, we proposed a rapid oscillation in the manner shown. But giving the matter further consideration, it was realized that this option facilitated no escaping from a situation where an electron passes from an s-orbit on atom 1 to an s-orbit on atom 2, at some point, whereupon $\Delta l = \pm 1$ would be violated

In respect of our having to revise the proposal illustrated in Figure 2 above, whereupon in an individual atom involved in molecular bonding, the valence orbit oscillates rapidly between s- and p-, we propose that, where there is ambiguity, the molecule in question simply designates to each atom, by some manner of microscopic process, a permanent aliquot of s-, or p-, and it stays that way.

METHOD

Now the next proposal we make is that when an electron is being transferred between two atoms, if it is going from a p-orbit to an s-orbit, that is called a double bond, (π -bond, in addition to σ -bond), and if it is going from s-orbit to p-orbit, that is a single bond, (no π -bond, only sigma). We could have called it the other way around, but having no theoretical whim on which to act, we make that choice arbitrarily and preserve it. We shall find, presently, that an individual pi-bond, in the absence of aromaticity, is in fact an aromatic system with $n = 0$. (A cyclic compound is aromatic if it has $4n + 2$ π -electrons). Consider a string of carbons, with arbitrary allocation of hydrogens only. If all CH_2 , then no π -bonding. $-\text{CH}_2-\text{CH}_2-\text{CH}_2-\dots$. If all CH , then conjugated double bonds. $-\text{CH}=\text{CH}-\text{CH}=\text{CH}-\dots$. If no H at all, then, theoretically, all bonds are double bonds, or alternately single and triple bonds. $-\text{C}=\text{C}=\text{C}=\text{C}-\dots$, or $-\text{C}(\text{T})-\text{C}-\text{C}(\text{T})-\text{C}-\dots$. This does not occur in nature, and we shall not concern ourselves with these two hypothetical situations. Now when you have an aromatic ring, you have such a sequence of carbon, $-\text{CH}-\text{CH}-\text{CH}-\dots$, that closes in upon itself. And you have conjugated bonding, as described above, but exhibiting a property called resonance. This only happens with $4n + 2$ π -electrons, as mentioned above, which means the ring has to contain 6, 10, 14, etc carbon atoms in the ring. And we are about to make a proposal that a carbon-carbon double bond in isolation is in fact an aromatic system with $n = 0$, i.e. two carbons, two π -electrons.

We have ascertained, in the theories put forth above, that an s-orbit does not have a uni-directional flow of charge, as proposed by the arrows in Figure 1 above, but an oscillating movement of electric charge, moving towards

and away from a node, in exact analogy to the ether oscillations inside the fermion, e^+/e^- , itself. Now we make the following proposal. In an aromatic system, where you have a ring, a circle, of moving charge, the individual s-orbits give up their "oscillation", about their respective nodes, to the ring, as a whole. This means that there is one specific atom in the ring, which serves the purpose of the "node". But even in this one, special atom, it has given up its property of charge oscillation, the charge moves uni-directionally about this orbit, for a given "phase" of the aromatic molecule. The "phase" of the molecule switches rapidly between "phase 1", say clockwise movement of the electronic charges, and "phase 2", say anti-clockwise movement of the electronic charges.

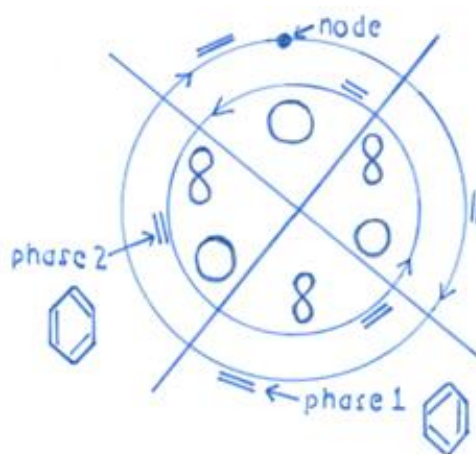


Figure 3: A benzene molecule. Double bonds exist when charge is moving from p- to s-orbit. The respective double bonds, in phase I (clockwise phase of the electronic oscillation), versus phase II (anti-clockwise phase of electronic oscillation), the double bonds are as indicated. The "node" carbon is at 12 O'clock. We call the carbon at 6 O'clock the "anti-node", this is where the speed of the electric charges is maximal, $v = c$. It is a fair bet that the carbon at the node is in the s-state, and the carbon at the anti-node is in the p-state. The two chemical depictions of the resonance of benzene, are as indicated, corresponding to phase 1 and phase 2 respectively

Now generally, resonance in aromatic rings will be exactly as depicted for benzene in Figure 3, but with larger numbers of carbons, that is, instead of 6 carbons, we'll have 10 carbons, 14 carbons, 18 carbons, ..., in accordance with $4n + 2$. This " $4n + 2$ " describes simultaneously the number of carbons in the ring and the number of π -electrons in the ring. Why $4n + 2$? Well firstly, it is evident that there will have to be an even number of carbons, to satisfy the symmetry we observe in Figure 3. And there is going to have to be an s-orbit carbon at the node, and a p-orbit carbon at the anti-node. That accounts for the "+2". It is clear that if we add another four carbons to the ring, going into the non-node, non-anti-node positions, exactly the same symmetry will be achieved as in Figure 3, and the ring will be aromatic. But what if we add just two carbons and not four. That is, 8 carbons, it does not satisfy " $4n + 2$ ". The best explanation we can give at this point is that, if

you do that, the carbon at the anti-node position will be in an s-orbit, akin to the carbon in the node position, and the molecule would not be able to figure out which is the node and which is the anti-node!

That gives a good account of aromaticity. But what about $n = 0$? That is, two carbons and two π -electrons. Is this not the “trivial” aromatic ring? We deduce that this is, in fact, the case. So, we return to Figure 2 above, but this time without the oscillation, the “resonance” which we mistakenly put forward, a long time ago, to make our molecular orbital consistent with aromaticity. We do away with that model and replace it with a better one. In a single carbon-carbon interaction, $n = 0$, “+2” carbons, “+2” π -electrons, you just have your node, s-orbit, and anti-node, p-orbit, with no other carbons in between. In this case, the s-orbit resumes its property of charge oscillation, its “node” is restored. We have the same rule as before, when the electric charge is moving from p- to s-orbit, the bond is counted as double, in reverse, it is counted as single. Consider phase 1 in Figure 3 above, when the charge gets to the first p-orbit, a double bond is instituted, because the charge is now in the process of moving from p- to s-orbit. In the trivial case, $n = 2$, two carbons, two π -electrons, this “first p-orbit” is the carbon itself at the anti-node. So for the return journey, back to the s-orbit, the possessor of the node, the bond is counted as double. When it comes back in contact with the node in the s-orbit, the bond becomes single again, the electron is on its way back to the p-orbit. So the p-orbit in its entirety retains the property of being the anti-node, but the node is now re-defined as being that isolated point in the s-orbit where the direction of the electron is reversed. And we have an oscillation between single and double bond, a resonance, in exactly the same manner as we do for larger “aromatic rings”, $n \geq 1$.

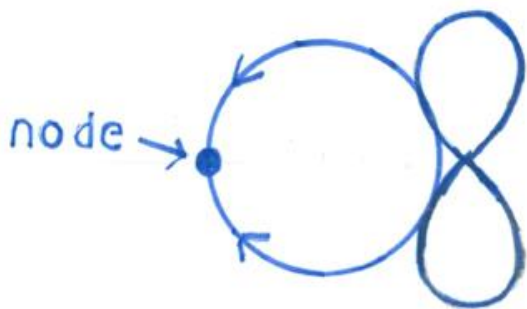


Figure 4: In the “ $n = 0$ ” aromatic ring, the isolated double bond, non-resonance, the s-orbit recovers its anti-node, ceases being an “anti-node in its entirety”. The p-orbit remains the anti-node, in its entirety. The bond is single from the time of contact with the node until the charge touches the p-orbit, when the bond becomes double again, for the entirety of the journey back to the node. Accordingly, the same “resonance” occurs as for the aromatic ring with $n \geq 1$, but without the need for switching between s- and p- orbits at an individual atom

About all there is to say in addition to that is in regard, to the $-\text{CH}-\text{CH}-\text{CH}-\dots$ situation, the conjugated double bond. When such a molecule is formed, a specific identity for

each carbon, s- versus p-orbit, is chosen, and it stays that way. As is also the case for aromatic molecules, of course. But in the chain of conjugated carbons, the carbons, in pairs, behave like aromatic molecules, with $n = 0$. How to decide which carbons are paired, where the double bonds occur? That just depends on the ends of the molecule. For example, the molecule $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{CH}_3$. There is only one manner in which the oscillating, resonating double bonds can occur. But you need to preserve $s \rightarrow p \rightarrow s \rightarrow p \rightarrow \dots$. When the molecule initially forms, some decision, based on a microscopic process, is made concerning say whether $\text{H}_2\text{C}=\text{}$ on the left side of the molecule is in an s-orbit or a p-orbit, and then based on that decision it is determined which of the double-bonded carbons in the molecule are nodes, (s-orbits), and which anti-nodes, (p-orbits). That is, all carbons to the left of the double bonds will be nodes, or all carbons to the left of the double bonds will be anti-nodes. This microscopic decision is made at the formation of every individual molecule, and for large numbers of molecules, 50% of molecules will have an s-orbit at this position, and 50% will have a p-orbit at this position. Therefore, it makes chemical sense to propose that, between two adjacent molecules, rather than an s-orbit to the left say and a p-orbit at the right, that there is in fact a p-orbit at both locations, because on average, that is a fact!

Probably not the case that in an aromatic ring, $n \geq 1$, the charge has zero velocity at the node, maximal $= c$ at the anti-node, and uniform acceleration in between. Because the electrons will be confined to s-, p-orbits, speed c . In this respect not entirely equivalent to the quantum harmonic oscillator, which describes the oscillating either within fermions, e^+/e^- . But there is some fundamental part of physics, which says “there will be a (net) circular propagation of charge, whereupon the charge oscillation occurs each side of a “node”. In much the same reason as there is a fundamental part of physics which says “there will be field lines, E, B , constrained to a helix, in agreement with the extremization of the space-time 4-vector, (t, x) . Then this law of physics will apply separately to the quantum harmonic oscillator, (ether oscillation in fermions, e^+/e^- , and $n = 0$ aromatic rings, i.e. individual π -bonds), and to the aromatic ring, ($n \geq 1$). In one case the charge velocity will be a constant, c , and in the other case the charge will undergo a uniform acceleration between node and anti-node. (That is where the quantum harmonic oscillator departs from the classical, in the latter, you have variable acceleration, $a = -kx$). So, in fact, there are three different varieties of oscillator:

Classical harmonic oscillator, $a = -kx$, spring and small θ pendulum, applicable in terms of quantum theory via molecular vibrations,

Quantum oscillator, $a = \pm \text{constant}$, aromatic oscillator $n = 0$, ether oscillations internally to fermion, (e^+/e^-), and:

Aromatic oscillator, ($n \geq 1$), $a = 0$.

So, for $n \geq 1$, you have that net circulation. In fact, it is not just a “net” circular oscillation, it is an exact circular oscillation, as observed looking down on the ring. (Even though looking sideways, the charge is going all over the

place). But because the intermediate s-orbits do not display that “circular quantum harmonic oscillation”, then neither does the s-orbit at the node position. The charge simply travels around the extremity of the s-orbit, and returns, whence it came. But if you go over to the $n = 0$ pi-bond, there is no evident “circle”. The charge oscillates between the s-orbit and the p-orbit, but it is certainly stretching a point to say that this will be a “circular” oscillation of charge. So, you just go back to the s-orbit itself being the circular path. Wherein the node is reinstated at the extremity, from the p-orbit, of the s-orbit. And if it is necessary, we are in a position to argue that for $n = 0$, (isolated pi-bonds), it is possible that the circular path exhibits full quantum harmonic oscillator behavior, that is, the electron accelerates from zero at the node to c at the anti-node, whereupon it leaves the s-orbit and travels around the p-orbit masslessly, for the entirety of the p-orbit, speed = c . The p-orbit does not touch the s-orbit, (it does in a σ -bond). The p-orbit provides a diversion from the electron crossing what would be the anti-node, opposite the node on the circular s-orbit – the p-orbit becomes the anti-node, in its entirety! Correction: if the s-orbit is an oscillator type (2), quantum oscillator, then when it leaves the s-orbit, it hasn't yet achieved $v = c$, it would be doing that at the anti-node. Thus the new anti-node becomes the cross-over point on the p-orbit, the fermion achieves $v = c$ at that location, prior to slowing down to the appropriate speed when it re-enters the s-orbit.

Finally, we have an explanation for the triple bond. Molecular orbitals are made out of atomic orbitals, right? So we have sp^3 , a single bond in organic chemistry, made out of $1 \times s - + 3 \times p -$. Or sp^2 , a double bond, made out of $1 \times s - + 2 \times p -$.

Finally, a triple bond, sp , made out of $1 \times s - + 1 \times p -$. But consider going from a double bond to a triple bond. Starting with, say, an s-orbit on atom 1, and a px -orbit on atom 2. (The z -direction is along the bond axis). So can we then institute a py -orbit on atom 2, such that the two p-orbits on atom 2 interact with the solitary s-orbit on atom 1? It is possible, but then that s-orbit would support 4 electrons, would it not? We get around this problem by instead envisaging, for the third bond, a unison of the s-orbital on atom two with the py -orbit on atom one. That appears to solve the problem. It does, however, facilitate the query, what about the single bond? This has to be a pz -orbital on one atom interacting with an s-orbit on the other. As in figure 3, on the left.

π -Bonding and Aromaticity Reinterpreted

Problem 1: For a π -bond, the two nuclei are not equidistant from the plane of contact of the s- and p-orbit. Problem 2: we require the single bond component of the triple bond as a pz -orbit from one atom to be in contact with the s-orbit of the other. So, no matter what, you are going to have one s-orbit supporting four electrons. Problem 3: a long time ago, in “Chemical Physics”, we proposed the sp^3 hybridization, e.g. methane, to consist of a “resonance” between a central s-orbit of the carbon atom, connected, in a sigma bond fashion, with three hydrogen p-orbits, arranged in a tetrahedral fashion, and/or a central p-orbit of the carbon, with s-orbits of the hydrogens, arranged in a

tetrahedral fashion and sigma-bonded to it. That is, the line between the two hydrogens attached to one lobe of the p-orbit at right angles to one another. And a resonance between these two. We now revise it, one s-p arrangement or the other, no resonance between, simply one or the other depending on a microscopic process when the molecule is formed. And 50% of the molecule population in one sp state, 50% in the other. And we conclude, further, that in a triple bond the px -orbit and the py -orbit are on the one atom, the interacting s-orbit on the other atom interacting with both of them. And that s-orbit interacting with pz -, which is on the same atom as px - and py -. So, we discover one law of nature.

(i) “There will be a circular path, with a node on one side and an anti-node on the other, facilitating a harmonic oscillation”. Out of this, we acquire ether oscillations inside fermions, e^+/e^- , and oscillations of electric charge, inside Schrodinger s-orbits. And we also acquire aromaticity, $n \geq 1$. Out of this arises a new law.

(ii) “There will be a circular path, with a node on one side of it, and a p-orbit on the opposite side”. That p-orbit may or may not be a part of the circular path. So, $n = 0$, that p-orbit is not a part of the circular path, the circular path is the s-orbit, with an anti-node, but the p-orbit touches the anti-node, versus $n \geq 1$, that p-orbit is the anti-node. For both $n = 0$ and $n \geq 1$, a double bond is constituted when the fermion is on its way from the node to the p-orbit, and a single bond is constituted when the fermion is on its way from the p-orbit back to the node. The instant the fermion touches the p-orbit, the bond is reversed, single $\rightarrow$ double, and the instant the fermion touches the node, the bond is reversed, double $\rightarrow$ single.

How “circular” is that path of electric charge around a benzene ring? If it were hexagonal, as per the usual chemical depiction, see Figure 3 above, then that is not all that circular. But in accordance with the laws proposed in the paragraph above, we would have it circular! What if the atomic radius, the carbon radius, is very small, compared with the ring? So we institute the ring, as a fundamental physical entity, in much the manner that you institute the electromagnetic helix, as a fundamental physical entity. And the carbon entities go in as minute additions, spaced at angles $\pi/3$, preserving the circular path. Well, is the size of the carbon atom very small compared to the size of the ring? Indeed! A carbon-carbon bond is quoted at 154 pm, whereas you have the carbon radius at 0.0914 pm $\sim$ 0.1 pm. So, the carbon-carbon bond is around 1500 times the length of the carbon radius.

But that raises another question. If molecular bonds are formed by the “touching” of the respective valence orbits of the two atoms in question, then there is no way that the bond length could be 1500 times the atomic radius. Proposition: when a chemical bond forms, the valence orbits, participating in the bonding, are promoted from principal quantum number: $n \rightarrow n + 1$.

This will not violate the conservation of angular momentum, because the new orbit has the same value of l as the valence orbit from which it was promoted. The orbit

has the same shape, e.g. $l = 1$, single dumbbell, p-orbit, but is just much larger.

And $s = 0$, the spherical orbit, s-orbit, is also involved. And the size of the atomic bond, we hope, will increase accordingly.

Does the size of the hypothetical C-C, or C=C, increase enough if we promote the p-orbit, $n \rightarrow n + 1$, and the s-orbit: $n \rightarrow n + 1$. The obvious way to confirm this is to look at the atom in the periodic table that is in the same group as carbon, except one position down. $n(l) \rightarrow n + 1(l)$, Silicon. Radius of Silicon quoted at $0.2 \text{ nm} = 200 \text{ pm}$, in comparison with C-C = 154 pm . It works! We don't want to be too quantitative about it, because bond lengths can vary by vibration, therefore atomic sizes will vary in vibration. So for an atom of a standard size, radius, that size is permitted to vary about an equilibrium value, yes, Schrodinger orbits can vary in size, analogously to the variation of orbital radii in the Bohr quantization condition, $2\pi R = n\lambda$. So 200 pm (Si) versus 154 pm (C-C) is certainly in the required ball-park – from that point relatively minor adjustments can be made, according to as the atoms in question would have it. Does the same thing occur as you go to higher and higher n-orbits? Quite astonishingly, not so! Going further down the same group, the radius for Germanium is listed at 0.137 nm , and that of Lead at 0.175 nm , both of these not significantly different from Silicon. That is indeed a mystery, but it does not concern us, because we are looking at aromaticity of hydrocarbon, not of Silicon or Germanium or Lead.

In previous discussions we ascertained that an atomic s-orbit, where it becomes involved as a part of a molecular orbit in atomic bonding, does not necessarily retain its property of being spherical, it just becomes circular, like a Bohr orbit, (before one institute the “spin” of the Bohr orbit. Similarly, the p-orbit, when it becomes a part of a molecular orbital it stops “spinning”, loses its angular momentum, you are just left with the planar figure-of-eight. In some scenarios, at least, possibly in all cases of molecular bonding. So, for our benzene ring, you want the electron path to be circular, not hexagonal, right? Consider the plane of the benzene molecule, the x-y plane. You have the various p-orbits aligned with the z-axis, and s-orbits in between, at angular spacings of $\pi/3$. We require that the planar figure-of-eights and planar circles are not actually planar, they curve around the benzene ring, as appropriate, such that, from above, observe that the passage of electric charge as being strictly circular, in accordance with laws (i) and (ii) above. We require that the “plane” carrying the p-orbit “figure of eight” and the s-orbit circle is (a) perpendicular to the x-y plane that defines the ring, and (b) not actually a plane, but a plane curled around into a circle. So you take the plane of the page, as depicted in Figures 1, 2 and 4 above, the plane being the x-z axis, “y” into the page, then you fold it into a circle, preserving “z-axis upwards”, and you have the benzene ring, sitting on the x-y plane.

The chemists will have to admit that they got it wrong. Even if the pi-bond is an interaction between 2 px-orbitals, or two py-orbitals, on separate bonding atoms, it is not conceivable that such an interaction could occur over a distance 1500 times the size of those orbits. So, for one

reason or another, in organic chemistry we have that carbon promotes its valence orbital, $n(l = 0, 1)$ to $n + 1(l = 0, n)$. But is this exclusive to carbon, this $n \rightarrow n + 1$. It would appear that this is the case, if we look at silicon. Silicon atomic radius = 0.2 nm , Si-Si bond length $\sim 10-10 = 0.1 \text{ nm}$. To form a bond with itself, there is no need for silicon to promote its valence orbitals, $n \rightarrow n + 1$. And we have an agreement between the bond size for carbon-carbon, 154 pm , and the orbital size for carbon: $n \rightarrow n + 1$, 200 nm (Silicon), with reasonable deviations owing to the molecular orbital simple harmonic oscillator (molecular vibrations), $F = -kx$, where displacement, x , is a variable, (within reason, not $\Delta x \sim 1500 \times$ orbital size).

The nitty gritty of the aromatic ring, $n \geq 1$, the constant velocity (c), zero acceleration oscillation

We must describe an oscillation, for benzene, whereupon we have three π -bonds, associated with six electrons. It must accommodate a single node and a single anti-node. There are two phases, as depicted in Figure 3. We shall deal with phase 2, the “inner” oscillation, the anti-clockwise oscillation. Between phases, there must be a turn-around point, where clockwise $\leftrightarrow$ anti-clockwise. The turn-around point is facilitated simply by the electron going around an s-orbit and returning whence it came, not coming to a stop and reversing as per the $\pm$ acceleration oscillation, ($n = 0$ aromatic ring, single π -bond). Now we have seen that in the $n = 0$ situation, the π -bond is repeatedly switched on and off-again – when the electron touches the p-orbit, the bond turns on, when the electron touches the s-orbit, the bond turns off, a rapid oscillation. In a given phase, phase two in this consideration, when one bond is “on” the next bond, anti-clockwise in this case, is switched off, and the next one “on”, and so forth, until you get back to the node, and that is the end of this alternating process. In this case, the first π -bond anti-clockwise from the s-orbit at “12 O'clock”, (the node), will be switched on, the second off, and the third on.

Starting from the node, C6, we label the carbon atoms, anti-clockwise, C1, C2, C3, C4, C5 and C6. The anti-node is C3. Put our first electron at C1, the beginning of C1. It has just arrived at this location, the π -bond has just switched on. And put the second electron at the far end of the s-orbit at C3. It cannot be at the beginning of the C3 s-orbit, because if it were, π -bond number1 would just have switched off, and we require it to by just switching on.

Now π -bond number2 lies between C3 and C4. We require this bond to be turned off. So electron 3 to have just arrived at the s-orbit on C4. So that π -bond number2 is switched off. And we put electron at the far end of that s-orbit. Why? Because there is no other place to put it! Now π -bond number3 is activated, switched “on”, so we have an electron number5 at the beginning of the p-orbit on C5. So our sixth electron, on C6, has to be at the latter part of the s-orbit on C6, because if it were at the beginning of it then π -bond number3 would have just switched off, when we want it to be just switched on.

Note this very important point. The bond that is switched off has two electrons in the orbit on one side of it, (C4), and zero electrons in the orbit on the other side, (C3 – anti-node). One unique property of all the orbitals, to either

side. Another point concerning that matter – the bond in question has just turned off, because the electron has just moved from C3 to C4, but when it was on, there was an electron on the s-orbit at C4, the electron that is now on the far side of C4 was previously at the beginning of C4. And further, that electron on the far-side of the s-orbit at C4 has been there for a while! It was continually rotating in that orbit when the electron at the beginning of C4 left C3, terminating the double bond, and indeed when that electron entered C3, instigating the double bond!

Note that we couldn't put an electron on C3, the anti-node, because π -bond number2 wouldn't be switched off if this were the case. So, there is no electron on the anti-node. That is pleasing, because we want it to be distinguished from the other carbons in some manner. So, starting from "12 O'clock", the node, we have electrons either at the beginnings or ends of the various orbits.

C6 – end
C1 – beginning
C2 – end
C3 ← Anti-node, no electron, "0"
C4 – beginning
C4 – end
C5 – beginning

Now a similar thing would not be possible for an eight-carbon ring because we would expect:

C8 – end
C1 – beginning
C2 – end
C3 – beginning
C4 ← Anti-node, no electron
C5 – end
C5 – beginning
C6 – end
C7 – beginning

That is, instead of end-beginning on either side of the anti-node, you would have beginning-end. This would not work, because you have an empty p-orbit, and no electron on the near side of either of the adjacent s-orbits either. That accounts for the $4n + 2$ rule. Finally, for this phase, phase 2, you go through an additional sequence of electron movement, but with π -bonds number1 and 3 de-activated, π -bond number2 activated. And that is the end of phase 2. Then you do the whole thing again for phase 1, the clockwise component of the oscillation.

Now let's go into the second mode of phase 2. The double bond between C1 and C2 is de-activated, the double bond between C3 and C4 is activated, and the double bond between C5 and C6 is de-activated. Now firstly, since C1-C2 is de-activated, there can be no electron on the p-orbit at C1. And this bond has just turned off – there has to be an electron at the "beginning" of C2. C3-C4 has just been activated – there has to be an electron at the beginning of C3. Finally, C5-C6 has just been de-activated – there has to be an electron at the beginning of C6. So we have to account for the other three electrons, in the second mode of phase 2. Put one at the end of C2, the bond has just

switched off, when it was switched on, that electron was at the beginning of C2. Put one electron at the end of C4, the C3-C4 bond has just switched on, if that electron was at the beginning of C4 then the bond couldn't have just been switched on, because the electron on C4 would have just been promoted from C3. The only remaining place to put our sixth electron is at the end of C6, the C5-C6 bond has just turned off, our electron was at the beginning of C6 when the bond was activated. So, we have our electron positions for second mode of phase 2, let's go looking for symmetries between this and the first mode of phase 2. To begin with, let's repeat our end → beginning → end... analysis.

C6 – end
C2 – beginning
C2 – end
Between C2 and C3 ← Approaching anti-node on C3 as phase 2 cycle ends, "0"
C3 – beginning
C4 – end
C6 – beginning

In this respect, we have exactly the same symmetry as for the first mode of phase 2. The first mode describes the initial process at the node, (12 O'clock). You have an electron at the beginning of C6, to kick start the process, and you have empty positions at the beginning of C6 and at the end of C5. Conversely, for the second mode of phase 2, you have two empty positions on the p-orbit at C1 – this is the end of the cycle, the end of phase 2. The fact that it is the end of the cycle is accounted for the fact that you have two electrons circling, "turning around", on the s-orbit of C6, the node, "12 O'clock".

What else, for the comparison between the two modes? In mode two you have two orbits, both p-orbits, empty at C1 and C5. Either side of the node, C6! By comparison, in the first mode, you have just the one empty orbit, again a p-orbit, the anti-node. Symmetry, right? Either side of node, versus exclusively at anti-node.

Finally, consider orbits with two electrons, having established a symmetry regarding nodes with zero electrons. In the first mode, you have one "double", the orbit at C4 carries two electrons. And in the second mode, you have two doubles, C2 and C6. And, as luck would have it, C4 is smack bang in the middle of C2, C6!

What we establish now creates an irrevocable symmetry which puts the theory beyond any doubt of its correctness. With regard to the "symmetry of empty orbits", you have C3 (first mode) and C1, C5 (second mode). Thus, you have an upside-down triangle, linking the three p-orbits, by symmetry. Secondly, consider the orbits with electron "doubles". These are all s-orbits, by comparison with the "empty" symmetry, which were all p-orbits. And they are C2, C4, C6. You have an upright triangle, linking the three s-orbits. So the total symmetry here is the "super-imposed upright versus upside-down triangles.

Therefore, one may ask, about our two anti-nodes, our two "0" positions? One is C3, sitting comfortably in opposition to the node at C6, as phase two begins, the first mode of phase 2. The other "0" lies between C2 and C3, and

translating through the origin, through the center of the benzene ring, it takes an opposing position adjacent to the node at C6. And this is the second mode, the end of phase 2. This line projected from "0" (ii) is approaching the 12 o'clock, the anti-nodes become the common position at C3, the two electrons on the s-orbit on C6 are circling and the whole system is preparing to go into phase 1, whereupon the entire process we have described will be repeated, backwards!

So, just to repeat, as the phase ends, you have two empty electron positions on the p-orbit at C1, this is an affirmation that the starting process of phase 2, the first mode, is well and truly over and done with. And on the other hand, for the first mode of phase 2, you have two empty electron positions, at the beginning of the s-orbit on C6, and at the end of the p-orbit on C5. This is an affirmation that the phase is just beginning, we are in mode 1, we have the electron just starting things in the end position of the s-orbit on C6. It has just arrived there, from a clockwise circulation in phase 1, and it has done a single orbit at 12 o'clock, and phase 2, mode 1, is just beginning.

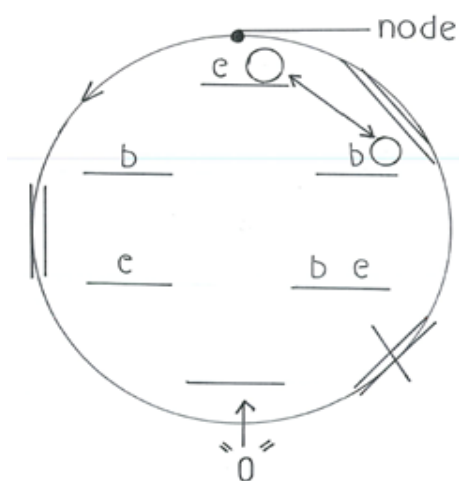


Figure 5: Benzene. First mode of phase 2. Activated and de-activated π -bonds as illustrated. "b" = electron at beginning of orbit, "e" = electron at end of orbit. Empty circles ($\leftarrow\rightarrow$) indicate absence of electrons, illustrating that phase 2 is starting from the node and going anti-clockwise

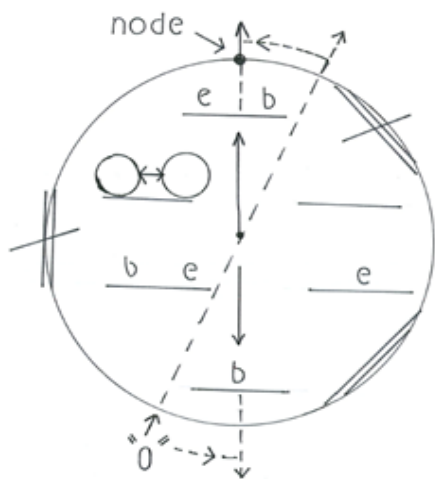


Figure 6: Benzene. Second mode of phase 2. Activated and de-activated π -bonds as illustrated. "b" = electron at beginning of orbit, "e" = electron at end of orbit. Empty circles ($\leftarrow\rightarrow$) indicate absence of electrons, illustrating that phase 2 is ending at the node, (anti-clockwise electron movement)

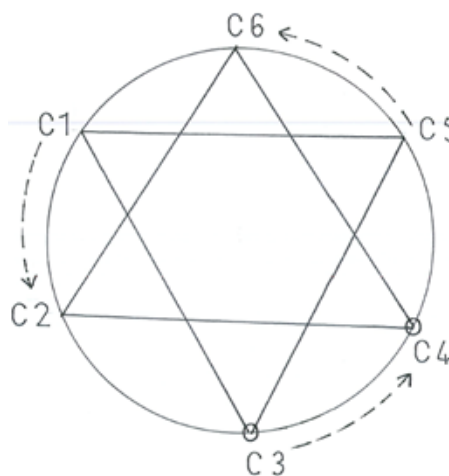


Figure 7: Upright triangle = electron doublet symmetry, inverted triangle = electron absence symmetry. Double bonds indicate p-orbit $\rightarrow$ s-orbit transfer of electrons. So start with the p-orbit symmetry, (inverted triangle), and rotate anti-clockwise $\rightarrow$ to s-orbit symmetry. Circle ($\times 2$) at triangle vertices designate the lone component of symmetry triplet.

RESULTS

The following results describe the behavior of π -bonds and electron oscillation dynamics in aromatic systems as derived from our proposed orbital interaction model. These results quantify symmetry, bond activation states, and electron positions for systems with varying degrees of aromaticity ($n = 0, 1, 2, \dots$). Note that we need s-orbit at "12 O'clock position", and consequently p-orbit at anti-node, because the aromatic ring reduces to a circular, $\pm$ acceleration, in the $n = 0$ case. For $n \geq 1$ aromatic rings, there is no acceleration, electrons travel uniformly at speed $= c$ around the various orbits

Orbital Nodes, Anti-Nodes, and Bond Dynamics

The $n = 0$ aromatic ring, isolated π -bond

So in benzene, in an individual phase, e.g. phase 2, you have the number of π -bonds activated at a given time oscillating between 1 and 2. And because electrons come in pairs, consider number of π -electrons $= (1 + 2) \times 2 = 6$. Correspondingly, in a single π -bond, i.e. $n = 0$ aromatic, you have the number of π -bonds at a given point in time oscillating between zero and one. And number of π -electrons $= (0 + 1) \times 2 = 2$. Continuing on with this proposition, we have for a 10 carbon aromatic ring, ($n = 2$), we have number of π -bonds at a given time oscillating between two and three. And number of π -electrons $= (2 + 3) \times 2 = 10$. And for a 14 carbon aromatic ring, we have number of π -bonds at a given time oscillating between

three and four, number of π -electrons = $(3 + 4) \times 2 = 14$. Etc. Therefore, one may ask, the point of all this? The point is that for an isolated double carbon bond, ($n = 0$ aromatic), the number of π -bonds activated at a given point in time does oscillate between zero and one. We were attempting to devise a model whereupon the π -bond is activated by one electron at the same time that the other electron would have it de-activated, such that the π -bond maintains a continuous existence of activation. However, we see that this cannot be the case. The molecule component must oscillate between zero and one π -bond activated.

So, for the isolated π -bond, $n = 0$ aromatic, we must devise a scheme where the molecule fragment oscillates between activation and de-activation. And it is evident that to achieve this, there is going to have to be periods of time, when both electrons are going to have to be on the same component of the molecular orbital, i.e. both on the s-orbit, or both on the p-orbit, and correspondingly, at those periods in time, the other atomic orbit will have to be empty of π -electrons. So it is consistent with the symmetry scheme we have devised for benzene, $n = 1$, Figure 7 above, whereupon such periods of time with some atomic orbits empty and some fully occupied with two electrons do occur. We are going to have to devise such a scheme for $n = 0$, sometimes one orbit doubly occupied, (and the other empty), and sometimes each orbit, s- versus p-, has just the one electron. And it is going to have to be devised with respect to the arrows of electron movement indicated in Figure 1, above.

So consider Figure 1. Put one electron at the left-most extremity of the s-orbit. The other in the direction of the arrow, around to the place where it is just coming into contact with the p-orbit. So this second electron, which is just entering the p-orbit, travels all around the p-orbit, in the direction indicated by the arrows, until it returns to its starting position, the point where it entered the p-orbit, but it is now leaving the p-orbit, returning to the s-orbit. In between entering and leaving the p-orbit, it at one point "touches" the s-orbit, at the lower point of contact between the s- and the p-orbit. But it is travelling in opposition to the arrow on the s-orbit! In previous discussions, we have argued that such a situation is possible, moving in opposition to arrows, if the point in question is a "node". But was that a different sort of node that we were talking about to nodes/anti-nodes in zero angular momentum s-orbits, oscillatory behavior?

The electron, electron number1, propagating from the node on the s-orbit, comes into contact with the p-orbit and moves onto the p-orbit. No node is required, because there is no opposition between the arrow of the p-orbit and the direction of motion of the electron. It travels until it passes through the new anti-node, situated at the symmetry point of the p-orbit. Now we always have the progression node $\rightarrow$ anti-node $\rightarrow$ node $\rightarrow$ anti-node $\rightarrow$..., etc. So it encounters the node at the second (lower) contact point of s- and p-, does not move onto s-orbit, because arrows are in opposition, need a node. Then it continues on, through the anti-node at the symmetry point of p-orbit, again, exits the p-orbit where it entered, (not a node or anti-node), and completes its motion on the s-orbit. To stay on the s-orbit, it must pass through a node at contact point number2, the

lower contact point, because arrows are in opposition, this has to be a node. Then it travels to the node at left-most of s-orbit, cannot travel through this point because node $\rightarrow$ node is disallowed propagation, so its velocity is reversed, turns around and repeats the whole process in reverse, this time with the upper contact point of the s- and p-orbit being the node. All arrows are reversed on the s-orbit. Node (this one, the node of the s-orbit, which it did not touch) $\rightarrow$ anti-node (symmetry point of p-orbit) $\rightarrow$ node, (this time upper contact point between s- and p-orbit) $\rightarrow$ etc, as before, but in reverse.

So our designation of "node" to the turn-around point of an ether oscillation inside a fermion, $e+/e-$, $v = 0$, and anti-node to point on opposite location of the "orbit", $v = c$ as opposed to $v < c$ everywhere else, was correct. We used the right word for it! After the turn-around, it is still credited as having come from a node, rather than an anti-node, but the node it came from, the lower "contact point", has lost its status as a node, the new contact point-node is now the upper one. So it can move back into the p-orbit and cross the anti-node at the symmetry point of the p-orbit, again. The node at the (lower) contact point of s- and p-orbit has gone out of existence, the node becomes the upper contact point of the two atomic orbits, instead. And the s-orbit direction has reversed but the p-orbit direction hasn't!

What about electron number2? Having described the path of electron number1, starting from s-orbit node and travelling clockwise to join the p-orbit, at what we call "contact point 1", (the upper s- versus p- contact point), we now have to put electron number2 into proceedings. At the time electron number1 "hits" the s-orbit node, rebounds, changing the direction of propagation of the s-orbit, starts the process we have described at length above, the s-orbit circulating now clockwise, electron number2 enters the s-orbit, from the p-orbit, at contact point 1, (upper contact point). It is in fact just completing the latter phase of the dual orbit that electron number1 will subsequently complete, as described above. So electron number1 will travel about half an s-orbit, by which time electron number2 hits the node and reverses. This is the time period Δt during which both electrons are on the s-orbit, the π -bond is de-activated. Electron number1 leaves the s-orbit about the time that electron number2 arrives at the node, in fact just prior to that, note that the position of contact point 1 is less than π degrees around the s-orbit from the node. So electron number2 reversing the direction of the s-orbit by rebounding from the s-orbit node is not a problem.

Note that the direction of propagation on the p-orbit does not change! Only the direction of the s-orbit changes. That satisfies angular momentum (s-orbit) = 0, oscillating one way and then the other, and it also satisfies angular momentum (p-orbit) $\neq 0$, (no such oscillation). So electron number2 does the mirror-image of what electron number1 has done/will do. Electron number2 travels the p-orbit, exits at upper contact point, travels to node, and just after rebound time, reversing the s-orbit circulation, electron number1 enters the s-orbit at contact point 2, embarking on the closing part of its journey.

That is, when electron number1 is beginning its journey, from the node on the s-orbit, electron number2 is

completing its journey, to the node on the s-orbit. The one electron comes onto the s-orbit when the other is on the far side, rebounding at the node. By the time the entering electron itself reaches the node, the rebounded electron is about exiting the s-orbit. It then has a full p-orbit before it will be back in contact with the s-orbit. But the entering electron will only be on the s-orbit for one half s-orbit, while the rebounded electron will be on the p-orbit for a complete orbit. Therefore, both electrons will certainly be on the p-orbit for a period of time, just as both electrons are on the s-orbit for a period of time, corresponding to the time it takes for either rebounding or entering electron to travel about a half an s-orbit. The π -bond is only activated for the time that both electrons are on the s-orbit. As soon as the rebounding electron leaves the s-orbit, the π -bond is activated. So let's try to create some order out of this somewhat chaotic situation. We have a time ordering of events, and assuming the time for a complete s-orbit $\sim$ time for a complete p-orbit.

$t = -1/2$: e-(1) enters s-orbit, (anti-clockwise s-orbit rotation).
 $t = 0$: e-(1) rebounds at s-orbit node, e-(2) enters, (clockwise rotation).
 $t = 1/2$: e-(2) rebounds, (anti-clockwise rotation).
 $t = 1$: e-(2) enters p-orbit, rotation of s- becomes arbitrary, (no electrons).
 $t \sim 1 1/2$: e-(1) re-enters s-orbit, (clockwise rotation).
 $t \sim 2$: e-(2) re-enters s-orbit, (anti-clockwise rotation).
 $t \sim 2 1/2$: e-(2) rebounds at node (clockwise rotation of s-orbit).

Then the process is repeated, swapping e-(1) $\leftrightarrow$ e-(2). So the total time for the procedure, until e-(1) gets back to where it started, and e-(2) gets back to where it started, $\Delta t = 2 1/2 + 2 1/2 = 5$ s-/p-orbits. So $\sim (1/2 + 1/2)/5 = 20\%$ of the time, the π -bond is de-activated. And compare $t = 0$ and $t = 5$. Are they saying the same thing? So take $t = 2 1/2$, but swap e-(1) $\leftrightarrow$ e-(2). That is, bullet point (7), e-(2) rebounds, clockwise rotation $\rightarrow$ e-(1) rebounds, clockwise rotation, in agreement with bullet point (2).

Finally, what about $t = -1/2$? This should be the same as $t = 2 1/2 - 1/2 = 2$, but swap e-(1) $\leftrightarrow$ e-(2), right? Bullet point (6), ($t \sim 2$) becomes e-(1) re-enters s-orbit, anti-clockwise rotation of s-orbit, in agreement with bullet point (1).

In $n = 0$ aromatic chemistry, we have the following in regards to nodes and anti-nodes. The characteristic node, "reflecting node", is in its usual position in the s-orbit, (to the left in Figure 1).

There is a new node at one of the two contact points of the s- and the p-orbit, that contact point where the two arrows are reversed from one another. The s-orbit anti-node, which was previously on the right-hand side of the s-orbit, has migrated to the point of symmetry of the p-orbit. The p-orbit provides a detour around that "would have been s-antinode", instead passing through the new anti-node on the p-orbit.

When arrows are in unison at a contact point, one does not call this "anti-node". When arrows are in opposition, one does call this "node".

Electrons entering p-orbits

Only the s-orbit can reverse direction, the p-orbit cannot, it is stuck with its direction of circulation around the "figure of eight". Although the orbit is now strictly planar, does not rotate about its z-axis any longer, the arrow going one way is akin to $m_l = +1$, and the opposed arrow, should we select it, is $m_l = -1$.

Rule 1: When an electron arrives at a contact point, where electrons of two respective orbitals are opposed, (node), and the new orbit (s-orbit) is empty, then there are two options:

The electron stays on its own orbit and the direction of the s-orbit is preserved, versus:

The electron moves onto the s-orbit, reversing its direction. So, what we mean when we say that "spin" of an s-orbit is arbitrary, when the s-orbit carries no electrons, is that its direction can be preserved, by an electron at a node on the contact point between s- and p-, not leaving the p-orbit, or its direction, "spin", can be reversed, by the electron entering the s-orbit. That is one manner in which the direction of an s-orbit can be reversed, the node at the contact point "spitting" the electron into the s-orbit. The other manner in which the direction of the s-orbit can be reversed is in the process wherein the electron reverses as it encounters the s-orbit node, the node that is on the s-orbit independently of there being another atom involved. Both reversals involve an electron moving away from a node, as the new s-orbit direction is instated.

Is it really possible to have an electron entering an empty s-orbit from a node? When the original electron that left the node on the s-orbit at $t = 0$ re-enters the s-orbit on its way to (permanent) s-node, that contact point between the lower lobe of the p-orbit and the s-orbit is no longer a node. Because e-(2) subsequently hit the s-orbit in a clockwise direction, travelled to the node, reversed the s-orbit direction and propagated back to the p-orbit, all occurring before e-(1) got back onto the s-orbit. So, when e-(1) (hits the upper contact point, this is now a node, because the p-orbit direction has not changed and the s-orbit direction was reversed to anti-clockwise by e-(2). So you have a node, upper contact point, e-(1) enters the s-orbit, which is devoid of other electrons, so e-(1) thereby causes reversal of the s-orbit, as we have hypothesized above. Leaving the node of the upper contact point, now no longer a node because direction of s-orbit has reversed, e-(1) then travels to the lower contact point. This is now a node, because e-(1) has reversed the s-orbit direction to clockwise. But node $\rightarrow$ node not possible! Well, the node at the upper contact point has disappeared, so e-(2) goes back to (coming from) anti-node status, officially, its last encounter with node or anti-node was with the anti-node at the symmetry point of the p-orbit. e-(1) passes through the "old anti-node" of the s-orbit, the one opposite the s-orbit permanent node that disappears when you bring the p-orbit into proceedings. It encounters the new node at the lower contact point and has no option but to carry on in its s-orbit pathway, because the direction of the p-orbit cannot be reversed! It then travels to the permanent node of the s-orbit, and is reflected, because it has the status of just having come from a node,

therefore is not allowed to proceed. As it reflects, e-(2) enters the s-orbit and travels anti-clockwise to the permanent s-node, itself. e-(1) travels back to the anti-node, symmetry point of the p-orbit, and is allowed to do so because the anti-node at the lower contact point of the two orbits disappeared when e-(1) reflected at the permanent s-orbit node, whereupon the direction of the s-orbit was reversed. So, in critical summary, when e-(1) commences its journey from the permanent s-orbit node, e-(2) enters the s-orbit and travels itself, clockwise, to the permanent s-node. Conversely, when e-(1) completes its journey back to the other side of the permanent s-node, and reverses, e-(2) commences its journey, anti-clockwise, to the s-orbit permanent node, whereupon it is reflected, and has the status of what e-(1) was originally, at $t = 0$. Then we do the whole process again until we are back at the true beginning, e-(1) travels clockwise from the s-orbit permanent node, again, etc.

Rule 2: Conversely, if there is already an electron on the s-orbit, then:

If it is a node, (s-orbit direction opposed to p-orbit direction), then p-electron cannot enter s-orbit.

If it is not a node, (arrows are aligned), (do not call this an anti-node), then electron enters new orbit, (s-orbit), if the electron already on the s-orbit is on its way from the s-orbit node. If it is not a node, and electron already on s-orbit is on its way to the s-orbit node, then second electron cannot enter s-orbit, because at some stage it will run into the other electron coming back from the s-orbit node. There is also the possibility, if the arrows are aligned, (not a node), and the electron on the s-orbit is on its way back from the s-orbit node, that the p-orbit electron stays on its orbit, does not enter the s-orbit. Please note that when we say “s-orbit node”, we mean that node that is a fundamental property of the s-orbit, not the additional node that occurs at the contact point of s- and p-orbits, where the arrows are reversed.

Spin, angular momentum and $n = 0$ aromaticity

Consider a fermion, e^+/e^- , propagating on an electromagnetic wave. Its spin (Q_e) is oscillating between forwards and backwards. Just a circle that defines the passage of electric charge, clockwise versus anti-clockwise, as we had in our $n = 0$ aromatic ring, individual carbon π -bond. But an electron is spherical, not circular! Solution, it has a “roll” as well, an angular momentum orthogonal to Spin (Q_e), giving it its 3-dimensional existence, its sphericity. Just as in a Bohr orbit, you start with a circle and then rotate to get a sphere, or in that case a “3D ellipsoid”, because you must take account of centrifugal force.

Now supposing you perform a measurement of Spin (Q_e). The fermion exits the wave, at right angles to the original direction. At this moment it has no momentum in the original direction, the direction the “roll” was propagating it in. Because it steps off the wave just as it stepped on, to be in the “stationary” frame where it interacted with the Reverse Higgs boson. It rolls off in its new direction, say to the right if Spin (Q_e) was “+” at the time of the measurement, and to the left if Spin (Q_e) was “-” at the time

of the measurement. We have net momentum forwards, (say, “z”), and spin oscillating between forwards and backwards $\rightarrow$ new momentum to the left or the right, depending on Spin (Q_e) at the time of the measurement, i.e. roll to the left or right, and we have new oscillating spin, oscillating between forwards and backwards in the direction of the new momentum. In some manner, there is a conservation of some substance that involves momentum, and spin $\leftrightarrow$ angular momentum, in this quite complicated procedure.

Perhaps we can ascertain what this “conserved substance” of linear momentum and angular momentum is. Suppose the fermion leaves the (original) photon to the right, Spin (Q_e) clockwise. You then do a secondary spin measurement. Say, Spin (Q_e) anti-clockwise, the momentum of the original photon is restored. But say, for the secondary spin measurement, we instead get Spin (Q_e) clockwise, the fermion now moves “backwards”, opposite to the momentum of the original photon. But supposing you preserve this spin, this secondary spin (Q_e) measurement, clockwise, but then rotate the secondary momentum vector by $\theta = \pi$ about the z-direction, the direction of the original photon. It is as if the Spin (Q_e) measurement on the original photon was reversed, Spin (Q_e) anti-clockwise, not clockwise. But, preserving the Spin (Q_e) on the second spin measurement, and rotating the secondary photon momentum vector back again, the fermion proceeds also in the direction of the momentum of the original photon. Yes! We have a conservation of some sort of substance regarding linear momentum and spin-angular momentum.

Now what about s-orbits? We require that they are spherical, just like ether oscillations inside a fermion, e^+/e^- . But we appear to have devised a model whereupon chemical bonds are planar circulations of electric charge, that is, we are concerned with the figure of eight p-orbit, not rotating, no angular momentum, and likewise a planar s-orbit, which is oscillating one way and then the other, in the plane. Well, consider a methane molecule, in its s-orbit central, hydrogen orbits being p-orbits. The major axis of symmetry of the p-orbit is pointing out from the sphere, on a line projected from the center of the sphere. The figure of eight is not rotating continuously, but it is free to take various angular positions about the spherical radial projector. For any particular angle θ , about the line projected radially from the center of the sphere, the planar s-orbit exists in the plane of the figure of eight. If the angle θ is arbitrary, then we have an arbitrary circulation by means of which we construct a sphere out of a circular pathway, just as for Bohr electrons and fermions propagating on electromagnetic waves.

Now consider our $n = 0$ aromatic ring. We are just concerned with processes in the plane of the s- and p-orbit. We are not concerned with arbitrary rotations of this plane. And similarly for the p-orbit, it no longer has any angular momentum, there is no rotation about its major axis of symmetry. Well, you cannot have any angular momentum for a non-rotating figure of eight. But you can for a circle, stationary in a plane. Indeed, this is how we get any angular momentum associated with an s-orbit, in the plane of the circle, but because $AM(s\text{-orbit}) = 0$, ($l = 0$), this has to be

an oscillating AM, such that the net AM is zero. So consider our planar $n = 0$ aromatic process. The figure of eight is devoid of any AM, so we are only concerned with the s-orbit part of the trajectory. At time $t = 0$, e-(1) commences its clockwise exit from the s-orbit. At around the same time, e-(2) similarly travels clockwise to the permanent node of the s-orbit. So that is " $2 \times \text{AM}$ (clockwise). By this time e-(1) has entered the p-orbit, so it is no longer in AM considerations. Then e-(2) reverses at the s-orbit node, returns the other way, anti-clockwise. So, $2 \times \text{AM}$ (clockwise) + $1 \times \text{AM}$ (anti-clockwise) = $1 \times \text{AM}$ (clockwise).

After this time, there is no fermion on the s-orbit, both electrons are propagating around the p-orbit, so while the s-orbit is still circulating, in the anti-clockwise state e-(2) left it in, it carries no fermion, so makes no contribution to AM. Then e-(1) gets back onto the s-orbit, propagates clockwise to the node, stops. At this point the direction of the s-orbit is under reversal, ready for e-(2) to travel clockwise to the permanent s-orbit node. But we stop there. This is exactly halfway through the process, $t = 2\frac{1}{2}$. We have a total processing of AM equal to $1 \times \text{AM}$ (clockwise), e-(1) & e-(2) contribution + $1 \times \text{AM}$ (clockwise), only e-(1) contribution = 2AM (clockwise). Then we do the whole process in reverse, this time a total contribution 2AM anticlockwise, to give a net expenditure of angular momentum = 0, for the process, at time $t = 5$, we are back where we started, and we say "the s-orbit has zero angular momentum". Consider the classical identity, $F = dp/dt$, where F is force, p is momentum. Convert to angular momentum considerations, $\tau = dl/dt$, where τ is torque, l is angular momentum. So for the first part of the journey, $t:0 \rightarrow 2\frac{1}{2}$, we have $\tau(\text{average}) = \text{"angular momentum$

processed/time" = $\Delta l/\Delta t = 2/(2\frac{1}{2}) = 80\%$, into the page, and for the second part of the journey, we have $\tau(\text{average}) = 80\%$, out of the page. Compare this with the time interval in which both electrons are simultaneously on the s-orbit, $0.5/(2\frac{1}{2}) = 20\%$, and you have $20\% + 80\% = 100\%$. This outcome illustrates conservation and symmetry in distribution — a result that is both consistent and elegant.

CONCLUSION

In this work, we have presented a reinterpretation of π -bonding and aromaticity based on orbital phase interaction, symmetry, and angular momentum conservation. By analyzing orbital overlaps and quantized motion around nodes and anti-nodes, we showed that π -bonds—starting even from $n = 0$ systems—exhibit aromatic characteristics driven by oscillatory behavior. This perspective extends naturally to classical aromatic systems such as benzene, where resonance can be described in terms of phase cycles and conservation principles, offering a new framework to understand electron delocalization in molecular chemistry.

DECLARATION OF INTEREST STATEMENT

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The paper is entirely original, and the only references pertain to original work in Physics, Mathematics and Chemistry which were carried out in the three published volumes of his work, "Grand Unification of the Four Fundamental Forces of Physics"[\[1\]](#), "Quantum Theory of Electrodynamics"[\[2\]](#) and "A Saucerful of Science"[\[3\]](#), all available right now on Amazon.

REFERENCES

- [1] J. R. Farmer, Grand Unification: of the four fundamental forces of physics, Amazon, 2021.
- [2] J. R. Farmer, Quantum theory of electrodynamics:, Amazon, 2021, p. 392.
- [3] J. R. Farmer, A saucerful of science: Amazon, Amazon, 2024, p. 1072.