Atomic Revolution:
Electron Orbital Model Based on The Vector Equilibrium
or
A Classical View of the Atom as a Tensegrity Structure

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Abstract

The model herein offers an alternative to the conventionally accepted concept of an ambiguous electron cloud and postulates a rather well defined structure and motion of electrons around the atomic nucleus that might explain how and why atoms bond with each other to form molecules as they do. If tested and verified, the model could be used to not only predict molecular configurations but also, in reverse procedure, design and engineer artificial atoms and molecules of immense potential, such as of superconductivity.

1. Atomic Structure

The model defines specific valence electron orbits for the atoms in the Periodic Table and might help to explain the principle behind the "octet rule," how single and multiple bonds work, and consequent molecular structures with their bonding angles and depths of penetration of interpenetrating atoms such as CO_2, C_2H_2, and CO, amongst others. It eliminates the need of "resonance" structures, for example, as a result of being able to explain more simply and effectively in three-dimensional and dynamic form what a combination of various models currently can.

The model is based on an Archimedean polyhedron known as the vector equilibrium, so called because all its inner radial and outer edge lengths are equal. The polyhedron is unique also in that it contains within itself the 5 Platonic configurations which define the stable geometry of electrons in the atom. The polyhedron has 25 axes of spin symmetric to its configuration. The planes perpendicular to and pierced by these axes define 25 great circles[1]. It is the premise of this model that Nature employs these great circles in her electron orbits, because they are the simplest, most efficient and economical routes available. While fully acknowledging the fact that the currently governing theory of quantum electrodynamics does not accommodate any such seemingly naïve concept of “orbits,” the model assumes such to interestingly obtain results that agree with observed phenomena. Moreover, specific orbits are selected for certain electron configurations to allow optimal preservation of such relationships while in motion. Since Pauli's Exclusion Principle stipulates that an orbit can only carry 2 electrons, an orbit can be considered as basically a "line" relationship between the positive-spin and the negative- spin electrons paired at opposite ends, moving in unison at 180-degree angle of maximum separation with greatest probability, minimizing electron repulsion and expending least energy.

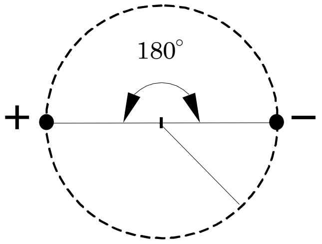


Fig. 1. Paired Electrons in an Orbit as a "Line" Relationship.

The model postulates that orbitals are "hybridized" in individual atoms to begin with and treats orbitals of different sublevels of a level as degenerate. Hund's rule, therefore, applies to all orbitals irrespective of the "penetration effect," and the model assumes that "the lowest energy configuration for an atom is the one having the maximum number of unpaired electrons...(with) parallel spins" [2] throughout the different sublevels.

1.1 Orbit and Orbital

An "orbital," in common atomic terminology, refers to a region of space where an electron is most likely to be found, as distinct from an "orbit," or path generally defined mathematically by a circle or an ellipse. In this paper, "orbital" and "orbit" are loosely used to indicate a sort of a hybrid of the two. While the orbits of the vector equilibrium diagrams are drawn rigid, they in actuality should not be considered as so. The drawings ought to be taken as ideal conditions, when attractive and repulsive forces always balance each other out at every phase of electron motion, when in actuality they do not. An electron is always under the influence of the positively charged nucleus as well as of the negatively charged electron, if any, and contingent on where it is at a particular instant, their effects vary. Hence, a perfectly circular orbit (or a spherical orbital), as indicated in the diagrams, is illusive.

1.2 Electron Configurations and Orbits

Level 1: 1 Orbit, 1-2 Electrons.

1 Orbit, 1 Electron:

H-Hydrogen: $1s^1$

1 Orbit, 2 Electrons:

He-Helium: $1s^2$

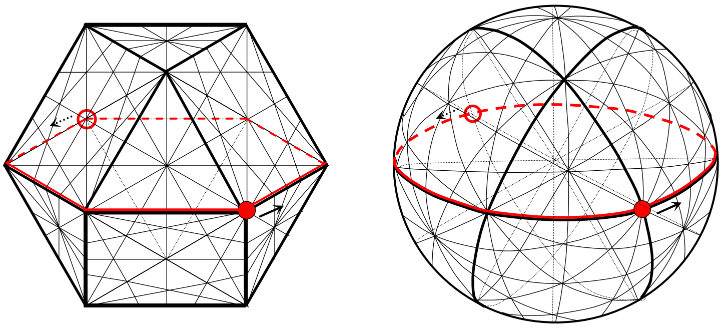


Fig. 2. Hydrogen - a Point; Helium - a Line.
While the orbits of the vector equilibrium diagrams are drawn rigid, they in actuality should not be considered as so.

The vector equilibrium is shown both in the polygon as well as in the inflated, spherical shapes for clarity of orbital routes. The electrons and the orbits in the foreground are drawn solid, while in the background the electrons are only outlined and the orbits dotted. Arrows indicate orbital direction.

While the electron orbital shell here is represented by level 1 of hydrogen and helium, it may apply to any other valence shell with the same number of electrons. The same applies to the shells henceforth presented.

Level 2: 3 Orbits, 3 Electrons
4 Orbits, 4-8 Electrons

3 Orbits, 3 Electrons:

B - Boron: $2s^1 2p^2$ $(2s^2 2p^1)$*

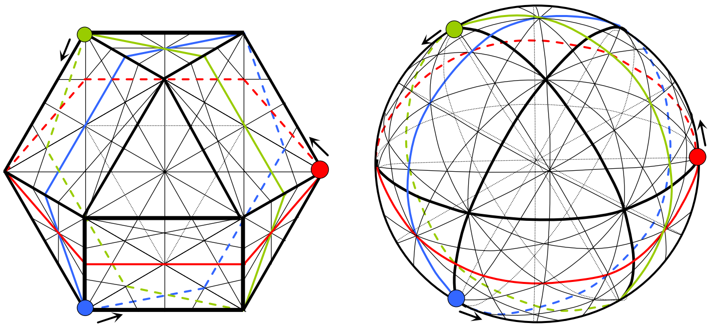


Fig. 3. Trigonal Planar

* It is generally accepted that boron and other atoms with three valence electrons are in the s^2p^1 form. It is postulated here that instead the form is of s^1p^2 to indicate that there are three orbits instead of two, because if there were only two orbits there would be two electron sep-aration angles of 180 degrees and 90 degrees.

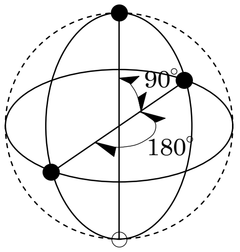


Fig. 4.

However, if there were three orbits, the configuration could be of trigonal planar with common separation angles of 120 degrees to minimize electron repulsion evenly.

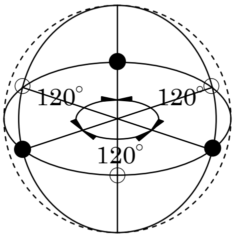


Fig. 5.

4 Orbits, 4 Electrons

C- Carbon: $2s^1 2p^3$ ($2s^2 2p^2$)*

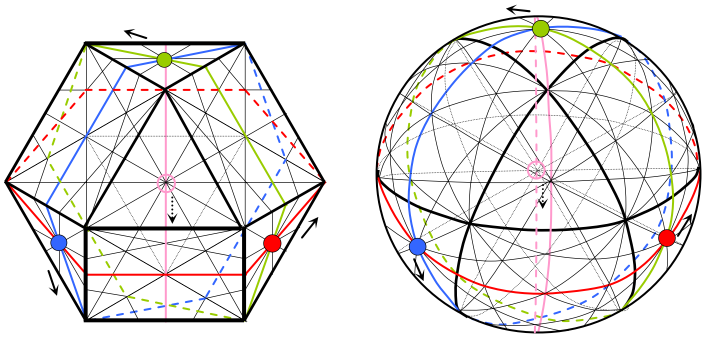


Fig. 6. **Tetrahedral**.

*Again, in order to minimize electron repulsion and to form the simplest, symmetrically balanced configuration, a 4-orbit system, rather than 3, is postulated.

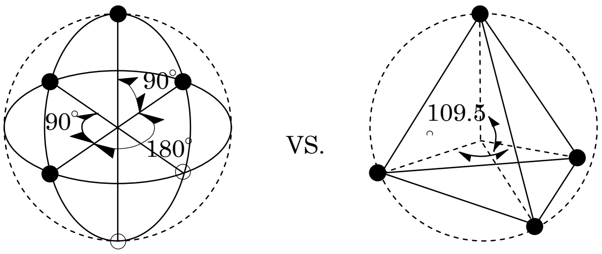


Fig. 7. **3 Orbits vs. 4 Orbits**

This tetrahedral configuration is the simplest, most stable, three-dimensional relationship that can exist among four electrons. This tetrahedral relationship might explain how atoms with half-filled valence shells are stable just as atoms with their shells completely full. The vital role of the carbon atom in organic life might be explained by such structural integrity as well as by its capacity to bond with other elements, being only half full, as shall be demonstrated henceforth.

Evidence to support this postulate that carbon has four orbits with one electron each may be identified in the way it bonds with, for instance, hydrogen to create methane. Since each orbit is half full, there is an empty slot at the opposite end of the orbit where an external electron could occupy. Since these slots are all at the opposite ends of the tetrahedral vertices, they in turn create another tetrahedral configuration. These are where the hydrogen atoms bond. Thus, this could be the reason that the molecular structure of methane is tetrahedral.

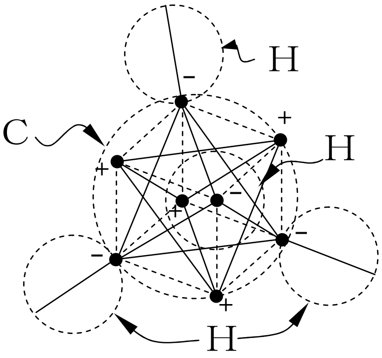


Fig. 8. Molecular Structure of Methane (with carbon electrons paired. Atoms not to scale).

When all the electrons in Fig.8 make half a revolution around their respective orbits, the resulting configuration is thus:

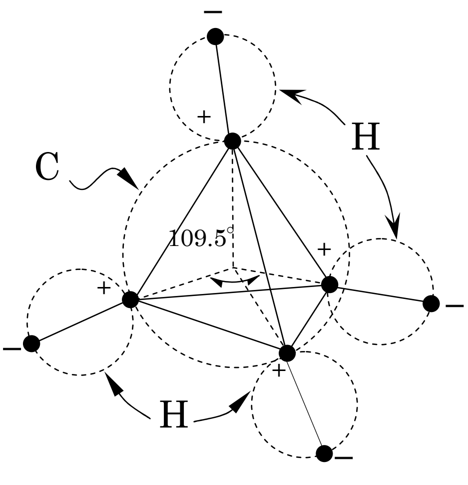


Fig. 9. Molecular Structure of Methane
(with hydrogen electrons paired, as seen from a different angle. Atoms not to scale).

When the single electrons of each of the four hydrogen atoms occupy the four empty slots of the carbon atom, the hydrogen electrons create another tetrahedron crisscrossing the original tetrahedron of the carbon electrons. Therefore, in effect, there are two interlocking tetrahedra, one comprised of carbon electrons, and the other of hydrogen electrons.

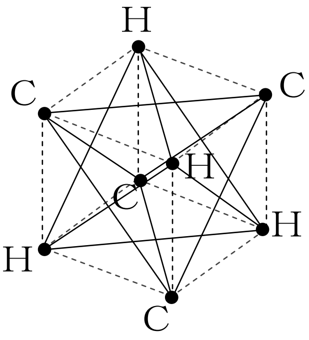


Fig. 10. Two Interlocking Tetrahedra in the Carbon of Methane.

The cube, comprised of the peripheral, right-angled edges, is a shape but not a structure. Only when braced by the diagonals that constitute the edges of either of the tetrahedra, the cube becomes a structure. Moreover, each electron of one atom is directly related to that of the other atom by the line that links the opposite ends of each orbit. A molecule such as methane is not only doubly braced by two tetrahedra but also reinforced by these four diagonals of the orbital lines that pierce through the center of the host (in case of methane, carbon) atom. These bracings might constitute the structural integrity for the principle of the "octet rule."

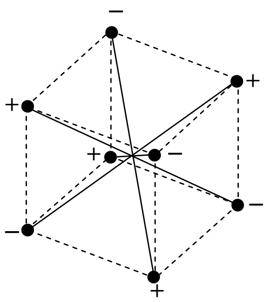


Fig. 11. Four Diagonal "Bracings" through the Center of Carbon in Methane.
"Plus" and "minus" signs indicate pairing of electrons of opposite spins.

Needless to say, these internal bracings pierce through the nucleus of the atom. Effectively, they are the tensile forces of the positively charged nucleus pulling on the negatively charged electrons, counterbalancing the compressional, repulsive forces of the electrons working on each other. In this light, the atom could be viewed as a tensegrity structure[3]. Simply, these electric, invisible "struts" are arranged in orderly geometry while electrons orbit around the atomic nucleus to render atoms and molecules their definite and regular patterns.

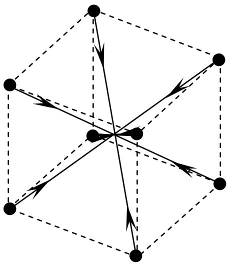
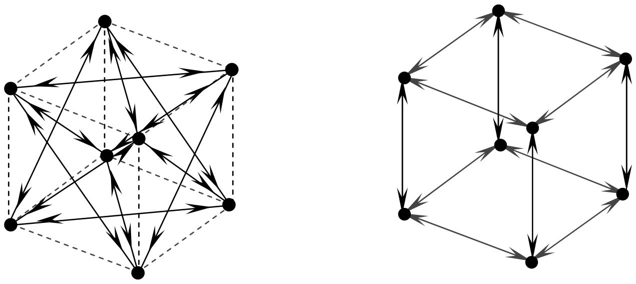


Fig.12. Internal Bracings as Tensile Forces.

These internal bracings in tension, piercing through the nucleus, constitute the so-called "lone pairs" in atoms and "bonding pairs" in molecules. In both cases of pairing, the positively charged nucleus acts as "the glue" to bond the negatively charged electrons.



Figs.13,14. External Bracings (Double Tetrahedra) and Peripheral Edges (Cube) as Com-pressional Forces.

4 Orbits, 5 Electrons:

N - Nitrogen: $2s^22p^3$

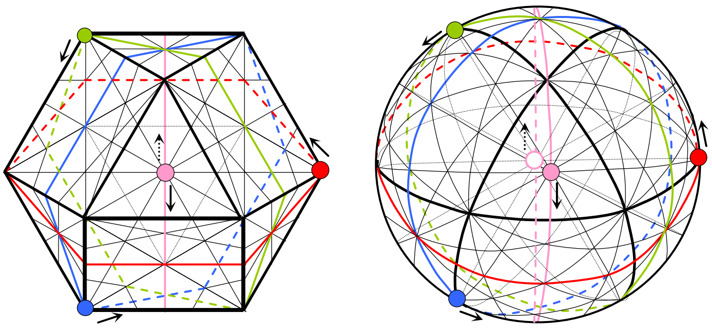
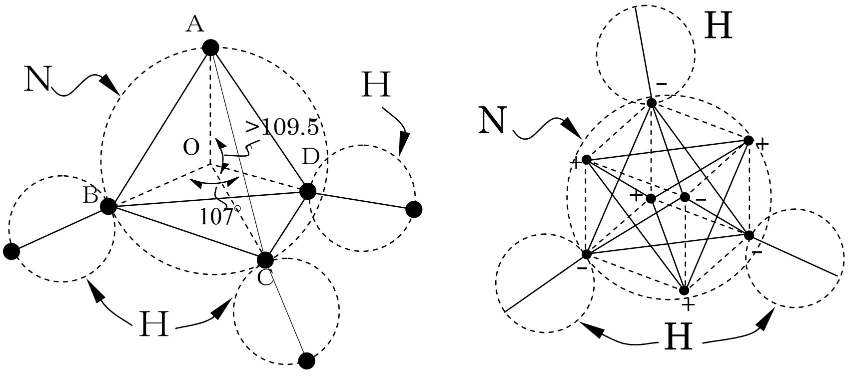


Fig. 15. Trigonal Bipyramidal.

The four orbits are the same as those of the previous 4-electron arrangement. The opposite end of the 4 electrons' pink orbit is now filled, and the 3 electrons of the 3 other orbits previously on the triangular faces, or tetrahedral vertices, move to three of the six equatorial vertices in order to balance electron repulsion.

Evidence to substantiate this configuration may be found in the way nitrogen bonds with three hydrogen atoms to form ammonia. The hydrogen atoms attach to the empty, opposite ends of the three non-paired electrons. In doing so, the three pairs of circumferential electrons move back to fill the six respective triangular faces, or tetrahedral vertices, in order to minimize electron repulsion by forming two intersecting tetrahedra as a whole. In essence, the hydrogen atoms are bonded to nitrogen at three of the four tetrahedral vertices. The bond angles, however, are not 109.5 degrees, as were the case with methane. Contrary to common belief that the so-called "lone pair," supposedly occupying the remaining vertex of the tetrahedral arrangement, takes up more space than the bonding pairs and thus compresses the bond angles to 107 degrees, the reason that the normal angle of 109.5 degrees is not maintained could be that the lopsided proximity of the three hydrogen atoms shifts the center of mass of the ammonia molecule such that the regular vector equilibral orbits of nitrogen become elliptical and shift themselves such as to reduce the bond angle to 107 degrees.



Figs. 16,17. Bonding Angles and Pairing of Ammonia (atoms not to scale. The 1 electron that pairs with A to form a lone pair is not drawn in the left diagram.)

This shift forces BC, CD, and BD to shorten, while it forces AB, AC, AD to elongate. As a result, angle BOD is reduced from 109.5 degrees to 107 degrees, while angle AOC is expanded to become greater than 109.5 degrees.

The paired electrons (DE) in Fig. 18 in the nitrogen atom are what is generally called "the lone pair." When the vacant slots of the unpaired ones (A,B,C) are filled by electrons of bonding atoms, in this case hydrogen, "bonding pairs" (AH, BG, CF) are formed.

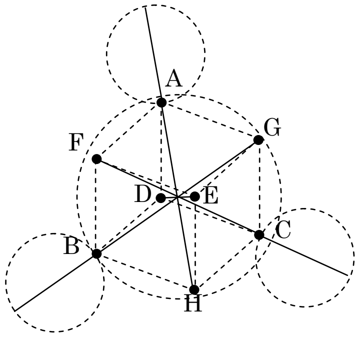


Fig. 18. "Lone Pair" and "Bonding Pairs" of Ammonia (atoms not to scale).

4 Orbits, 6 Electrons

O - Oxygen: $2s^2 2p^4$

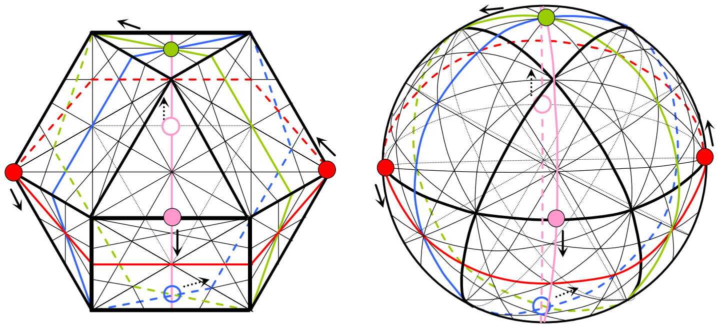


Fig. 19. Octahedral.

To the previous nitrogen configuration an electron is added to fill the red orbit. Since there are now 6 electrons and in order to minimize electron repulsion, the 2 pink electrons move from the triangular faces to their respective positions on the circumference of the vector equilibrium, while the green electron moves to the adjacent triangular face, and the blue electron likewise to the opposite side of the green. As a result, the new configuration is octahedral.

One may wonder why there are 4 orbits instead of 3, as they would suffice to pair the 6 electrons octahedrally. The reason may be in that otherwise an atom such as oxygen would not be able to accomodate any other electron to form molecules, as in the following example.

It is evident that while the red and the pink electrons are paired and their orbits complete, the green and the blue are not. When oxygen combines with hydrogen to form water, the 2 hydrogen atoms attach to the empty slots of the unfilled orbits. When this happens, all the oxygen electrons as well as the 2 hydrogen atoms' electrons occupy the 8 triangular faces to form 2 interlocking tetrahedra, or cube.

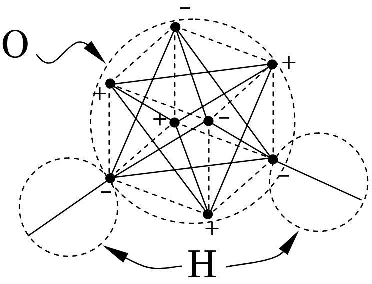


Fig. 20. Two Interlocking Tetrahedra in the Oxygen of H_2O (with oxygen electrons paired. Atoms not to scale).

The molecular structure is thus:

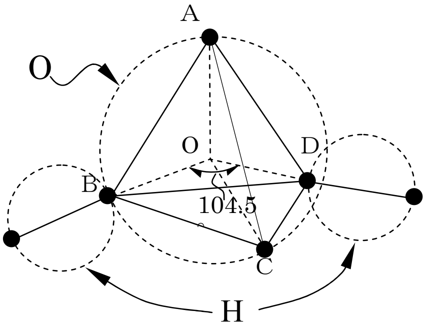


Fig. 21. Molecular Structure of H_2O
(with hydrogen electrons paired . Atoms not to scale. The 2 electrons that pair with A and C to form lone pairs are not drawn.)

As was the case with ammonia, the lopsided proximity of the hydrogen atoms shifts the center of mass of the resulting molecule from the center of oxygen to cause a shift in the regular vector equilibral orbits to reduce the bond angles. Since there are only two atoms this time and no third atom, the shift is increased in one direction, and the resulting bond angle is less than that of ammonia. Therefore a bond angle BOD of 104.5 degrees results.

4 Orbits, 7 Electrons:
F - Fluorine: $2s^22p^5$

4 Orbits, 8 Electrons:
Ne - Neon: $2s^22p^6$

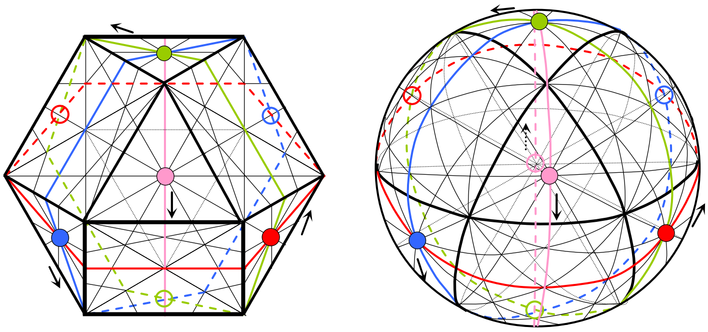


Fig. 22. Two Interlocking Tetrahedra (Cube).

This arrangement is the same as that of the water molecule, but in place of the 2 hydrogen atoms' electrons are the 2 new electrons. The 7-electron configuration is this minus one elec-tron.

Evidently, the stability of neon and other so-called inert gases might owe to the structural integrity of the two interlocking tetrahedra.

While only those configurations up to 4 orbits with 8 electrons are here presented, those up to 16 orbits with 32 electrons, such as Ytterbium (Yb) with the maximum number of orbits and electrons in a single shell, are believed to be operable following similar electron arrangements and great circle orbits of the vector equilibrium.

As has been demonstrated with examples of atoms and molecules, other atoms and molecules follow similar pattern of development from rearrangement of vector equilibrium geometry and great circle orbits. A simpler, albeit often approximate and sometimes crude, method of analysis and synthesis of atoms and molecules will now be presented to facilitate a three-dimensional visualization thereof. It has already been demonstrated with 8-electron configurations and is the double tetrahedra. However, in order to facilitate viewing electron as well as molecular arrangements of atoms, each atom shall henceforth be presented not as part of double tetrahedra but simply of cube, as follows:

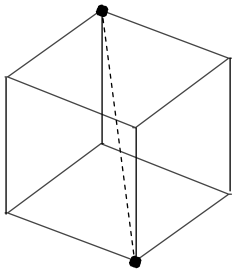
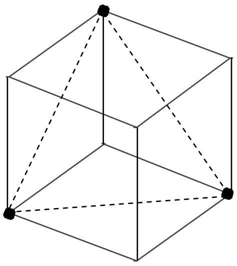
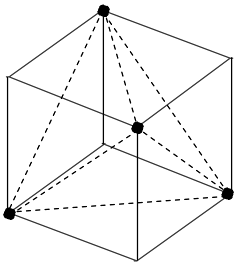
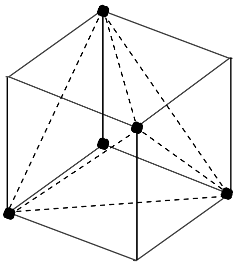
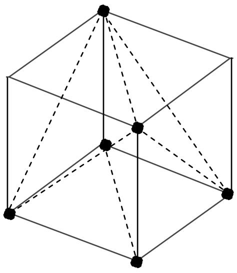
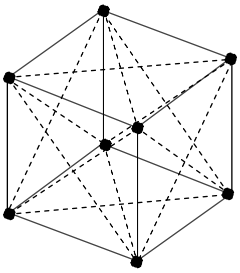
	Number of Orbits	**Number of Electrons**	**Electron Arrangements**	**Remarks**
	1	2	Linear	1 Pair of Electrons
	3	3	Trigonal Planar	Triangle small and lop-sided
	4	4	Tetrahedral	Regular
	4	5	Trigonal Bipyramidal	Triangle small and lop-sided. 1 Pair of Electrons
	4	6	Octahedral	Square rectangular and lop-sided. 2 Pairs of Electrons
	4	8	Double Terahedral	Regular. 4 Pairs of Electrons

Fig.23. Regular Arrangements of Electrons In "Cubes"

Except for atoms such as hydrogen (with only 2 valence electrons in a linear arrangement), which has 1 orbit, and atoms such as boron, which has 3 orbits, atoms with 8 valence electrons or less have 4 orbits. Electrons occupy each empty orbit first before pairing in a singly occupied orbit. This might be the reason that 2 hydrogen atoms bond to oxygen at an angle of 104.5 degrees, rather than180 degrees, and that 3 hydrogen atoms bond to nitrogen at angles of 107 degrees, rather than planar 120 degrees .

2. Molecular Structure Based on the Foregoing Atomic Structure

2.1 Phosphorous Pentachloride(PCl_5):

P - Phosphorous: $3s^2 3p^3$
Cl - Chlorine : $3s^2 3p^5$

Phosphorous has a total of 5 electrons and chlorine has 7 in their respective outer shells. As has been shown, the structure of phosphorous is trigonal bipyramidal.The molecular struc-ture of PCl_5 is thus:

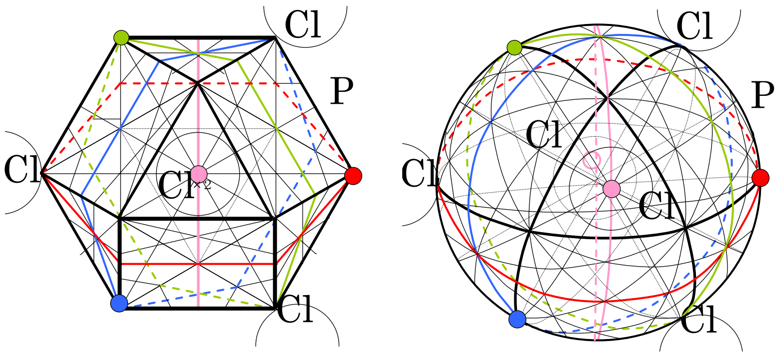


Fig. 24. Molecular Structure of PCl_5 (atoms not to scale).

3 chlorine atoms attach to the empty slots of phosphorous' 3 orbits, thus completing them. 2 remaining chlorine atoms attach to the opposite ends of the already filled fourth orbit. More simply and completely:

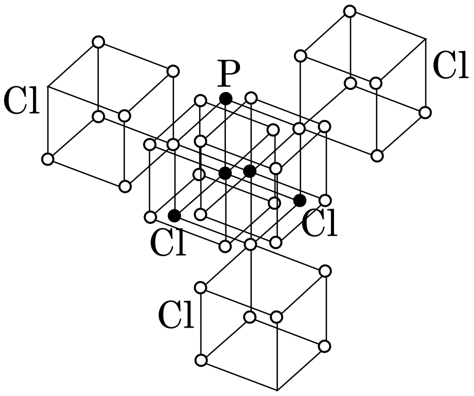


Fig.25. Molecular Structure of PCl_5.

Phase1: All Phosphorous' and 2 Chlorines' Electrons Paired with Trigonal Bipyramidal Configuration of Phosphorous Electrons.

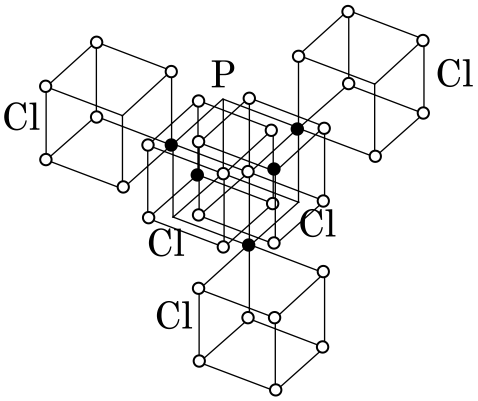


Fig.26. Molecular Structure of PCl_5.

Phase 2: All Chlorine Electrons Paired with 2 Phosphorous Electrons in Respective Chlorine Orbits.

Until the early 1960's, it was believed that the noble gases, with s and p valence orbitals filled, were not chemically reactive and were hence called "inert" gases. However, several compounds of krypton, xenon, and radon were synthesized to show that these gases were capable of reacting chemically [4]. The reason for this phenomenon is similar to that of phosphorous and chlorine electrons as follows.

In Phase 2, the paired electrons of phosphorous can no longer remain in their original orbit and move into those of the bonding chlorine atoms in order to make room for the pairing chlorine electrons. Thus, the unpaired electrons of the two chlorine atoms are able to each bond to the paired electrons of the one complete orbit of phosphorous.

Although the configurations in Figs. 25 and 26 are not perfectly symmetric trigonal bi-pyramidal (as the triangular set of 3 chlorine atoms attaching to the unpaired phosphorous orbits are closer to one end of the paired phosphorous orbit axis than to the other), in reality the chlorine atoms "wiggle around" to adjust their orbits in such a way as to form a symmetric arrangement as in Fig.24.

2.2 PCl_6^- Anion:

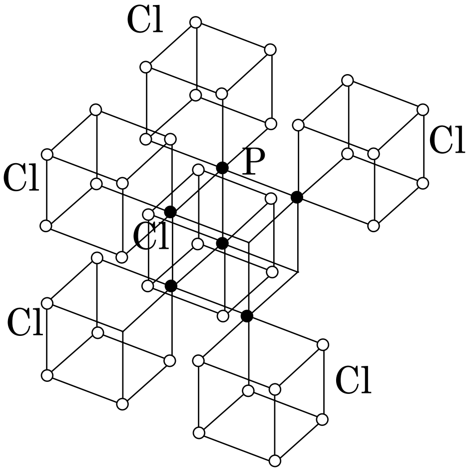


Fig.27. Molecular Structure of PCl_6^-.
Phase1: All Chlorine Electrons Paired.

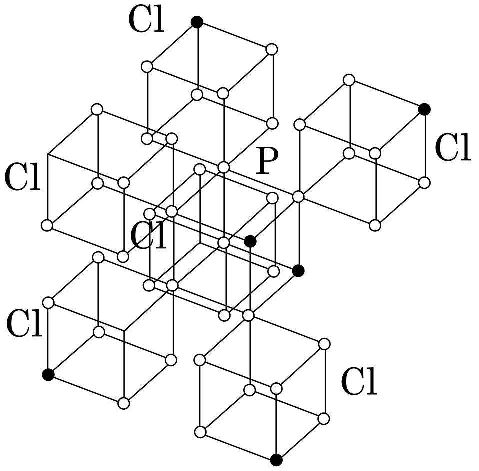


Fig.28. Molecular Structure of PCl_6^-.
Phase 2: All Atoms' Electrons Paired
except for 2 Chlorines'.

As shown in Fig.28, phosphorous electrons enter chlorine orbits in order to make room for the pairing chlorine electrons. Actual molecular arrangement is octahedral for best symmetric balance.

For sake of brevity, only the (black and white) cube arrangements without the (colored) vector equilibral orbits shall henceforth be used to explain molecular structures. While they are often not exact representations of the actual configuations, they are nonetheless complete and simple, as demonstrated with PCl_5.

2.3 NO_3^- Ion:

N-Nitrogen : $2s^2 2p^3$
O-Oxygen : $2s^2 2p^4$

All of the molecules thus far presented had tangential bonding, that is, they were merely touching each other at the shell surfaces. An example will now be presented where the bonding atoms interpenetrate each other.

With an electron added, all the atoms have 6 valence electrons each.

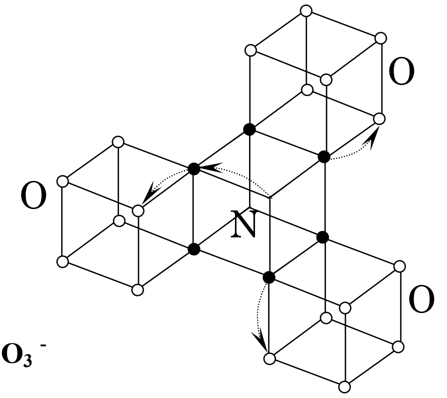


Fig.29. Molecular Structure of NO_3^- with 3 Double Bonds.
Phase 1: All Electrons Paired.

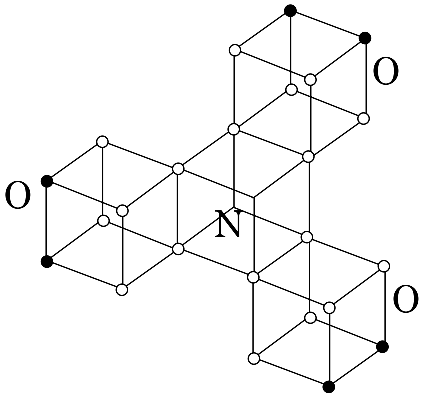


Fig.30. Molecular Structure of NO_3^-.
Phase 2: All Electrons Paired with Nitrogen Electrons in Oxygen Orbits (Ionic Bonding).

As is evident from the diagrams, the bond angles are 120 degrees. Again, it should be noted that nitrogen and oxygen have 4 orbits each, but with the addition of an electron to the molecule they have rearranged their electrons from their original tetrahedral configurations to those that fit the molecular structure (dotted jumps in Fig.29).

Structures such as NO_3^- are generally known as "resonance" structures and are basically a superposition of the possible Lewis structures. In case of NO_3^-, the molecular structure is expressed as follows:

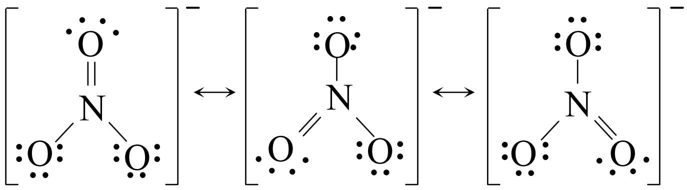


Fig. 31. Lewis Structure for NO_3^-.

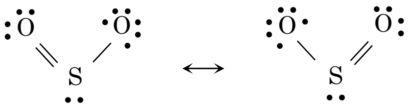
The localized electron (LE) model postulates that electrons are localized between a given pair of atoms. In reality, however, electrons are delocalized, and so the concept of resonance has to be applied to compensate for the defective assumption of this model [5]. In the model herein presented, atomic electrons are delocalized to begin with and therefore move about the entire molecule three-dimensionally when bonded to perhaps present a direct and more accurate picture of reality.

2.4 Sulfur Dioxide (SO^2):

Another example of a double bond is SO_2.

S-Sulfur: $3s^23p^4$

Resonance structures for SO_2 are:



The diagrams indicate 1 lone pair of sulfur and a bond angle of 120 degrees.

The molecular arrangement is:

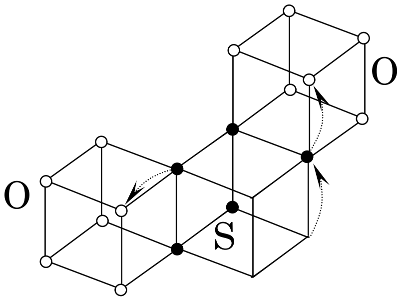


Fig. 32. Molecular Structure of SO_2.

Phase1: All Oxygen Electrons Paired.

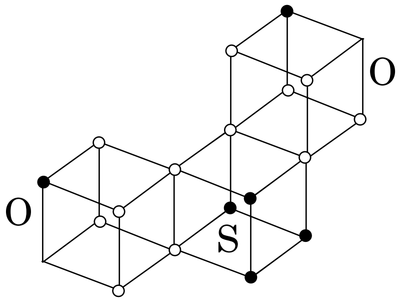


Fig. 33. Molecular Structure of SO_2.

Phase 2: All Sulfur Electrons Paired with 2 Sulfur Electrons in Oxygen Orbits.

It should be noted that sulfur and oxygen atoms have 4 orbits each, but their electrons have rearranged themselves from their original tetrahedral configurations to those that fit the molecular structure (dotted jumps in Fig.32).

2.5 Carbon Dioxide (CO_2):

The Lewis structure for CO_2 is : $\overset{\cdot}{\underset{\cdot}{:\mathrm{O}}} = \mathrm{C} = \overset{\cdot}{\underset{\cdot}{\mathrm{O}:}}$

There are two sets of oxygen-carbon quadruple bond. However, since each carbon electron is "double-timing," i.e., forming 2 bonding pairs with 2 oxygen electrons simultaneously, each bond is counted as half in the Lewis structure.

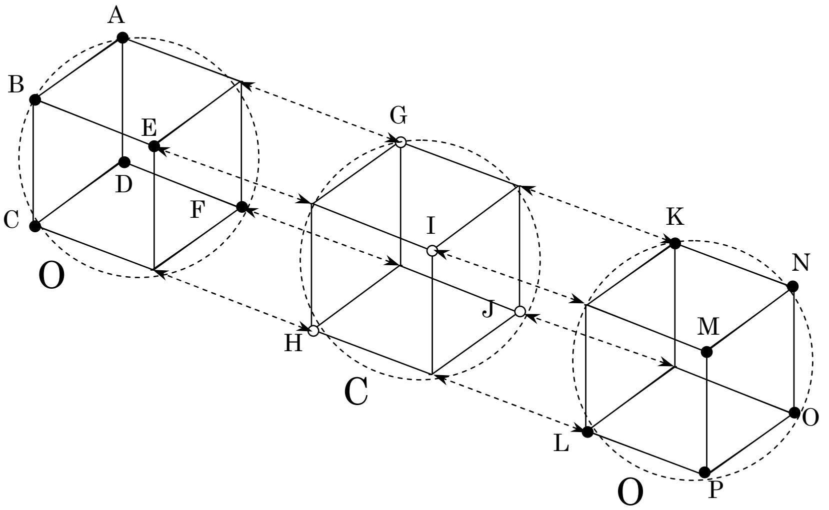


Fig. 34. Carbon and Oxygen Atoms before Bonding.

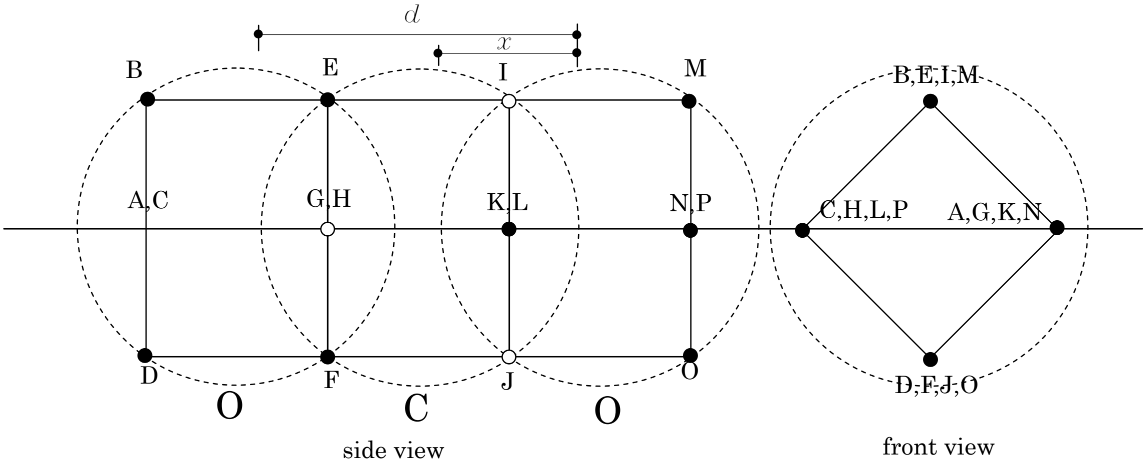


Fig. 35. CO_2 Molecule: Side View and Front View.
Phase 1: All Electrons in Their Respective Atomic Orbits (Covalent Bonding).

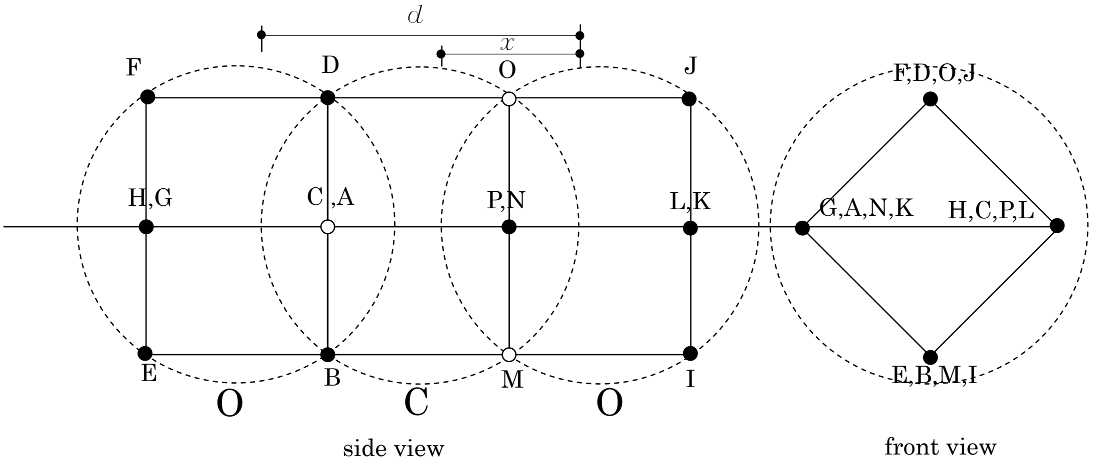


Fig. 36. CO_2 Molecule: Side View and Front View.
Phase 2: All Carbon Electrons in Their Respective Oxygen Orbits (Ionic Bonding).

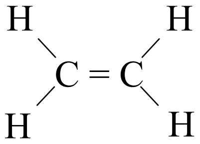
As is evident in the 2-phase diagrams of the CO_2 molecule, here is another case where a combination of covalent and ionic bonding occurs. In phase 2, the carbon electrons are not able to navigate along their own orbits, as the adjacent oxygen atoms respectively fill the empty slots of carbon when their electrons make half a revolution around their orbits. Hence, the carbon electrons at G and H, and at I and J trade places with those of oxygen at C and A, and at O and M respectively.

Carbon dioxide is thus linear with a bond angle of 180 degrees. Simple calculation of x, the depth of interpenetration for the atoms, assuming carbon and oxygen radii equal and disregarding forces of electron repulsion and nuclear attraction, indicates x to be roughly 42.5% of atomic diameter.

Atomic radii differ that the geometric relationships thus far presented are hence not exact. However, atomic radii are approximate to begin with, and it is theorized that in molecules, where electrons are often shared by all atoms involved, the atomic sizes ought to be more closely evened than when they are on their own , even though their atomic numbers differ.

2.6 Ethylene (C_2H_4)

The Lewis structure for ethylene is:



Since there is a carbon-carbon double bond, which is considered as one effective pair, it is generally believed that each carbon is surrounded by 3 effective pairs and therefore the bond is trigonal planar and the angles 120 degrees each. Each carbon actually has 4 bonding pairs: 2 hydrogen-carbon and 2 carbon-carbon. Altogether in the molecule there are 8 bonding pairs. However, two electrons of each carbon, E and H, I and L, respectively, are "double-timing," i.e., they are forming hydrogen-carbon, carbon-carbon pairs simultaneously, that their quadruple bonding is counted as half in the Lewis structure. Atoms lie in a plane and electron arrangement of individual atoms before bonding is thus:

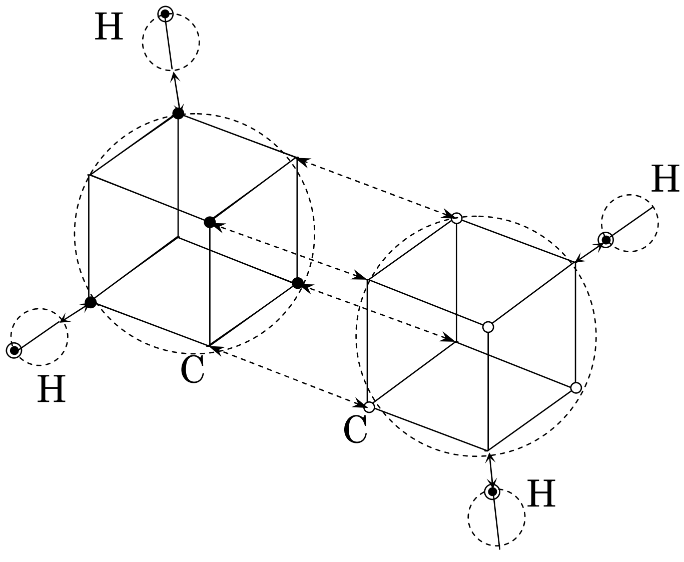


Fig. 37. Carbon and Hydrogen Atoms before Bonding (atoms not to scale).

Final arrangement is thus:

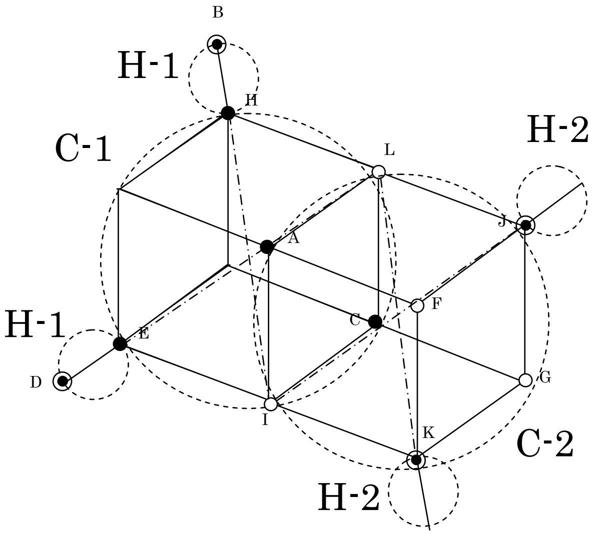


Fig. 38. Carbon and Hydrogen Atoms after Bonding (atoms not to scale).

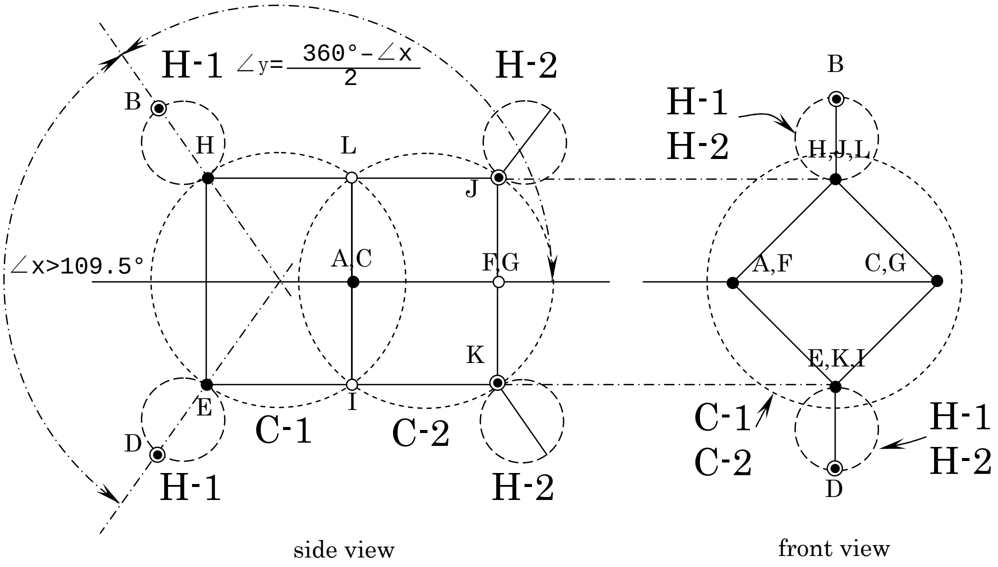
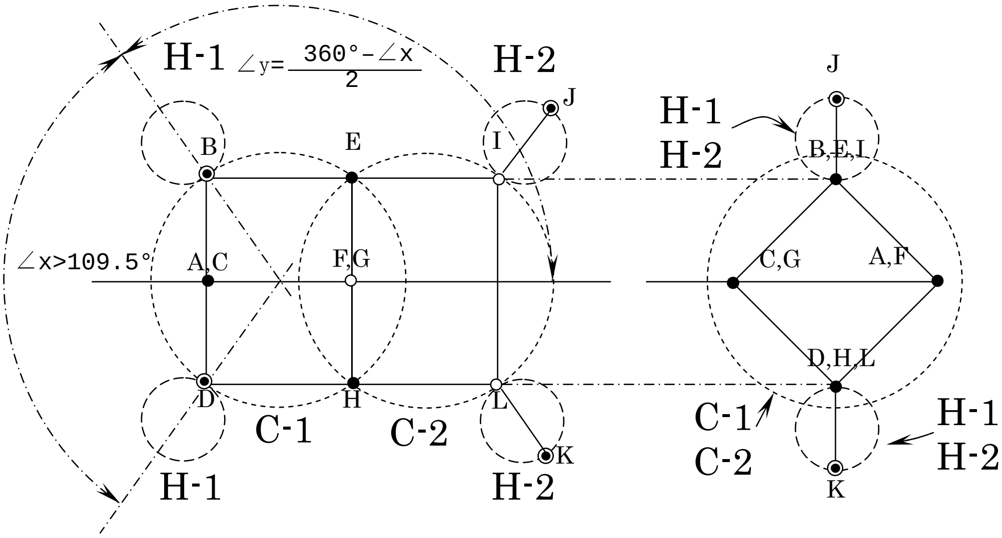


Fig. 39. Molecular Structure of Ethylene (C_2H_4).

Phase1: All of C-2 and H-1 Atoms are Paired (atoms not to scale).



side view front view

Fig. 40. Molecular Structure of Ethylene (C_2H_4).

Phase 2: All of C-1 and H-2 Atoms are Paired (atoms not to scale).

When all the electrons make half a revolution around their respective orbits, all of carbon-1 and hydrogen-2 atoms' electrons become paired (Phase-2). As is evident in the above figures, the molecule is basically two tetrahedra interpenetrating each other . How the 4 hydrogen atoms respectively attach to the carbon atoms is similar to those in methane (CH^4), but since the pair of hydrogen atoms attached to the adjacent carbon atom is now further apart and electron repulsion less, and also since the center of mass of the molecule shifts from the respective centers of each carbon to their bonded center, the regular carbon orbits shift to displace the position where hydrogen atoms would normally attach at 109.5 degrees, which is the angle in a regular tetrahedral configuration (as in methane). Hence, the resulting bond angle x between 2 hydrogen atoms is greater than 109.5 degrees but not necessarily 120 degrees. Atomic interpenetration is similar to those of CO^2.

2.7 Acetylene (C_2H_2):

The structural formula for acetylene is: $H-C\equiv C-H$

The formula indicates a triple bond between the carbon atoms. The electron configuration of carbon is tetrahedral with 4 unpaired orbits. This means there are 4 slots open at the opposite end of each electron. The 4 electrons and their unpaired opposite ends together form double tetrahedra. The 2 carbon and the 2 hydrogen atoms before bonding, individually, are as follows:

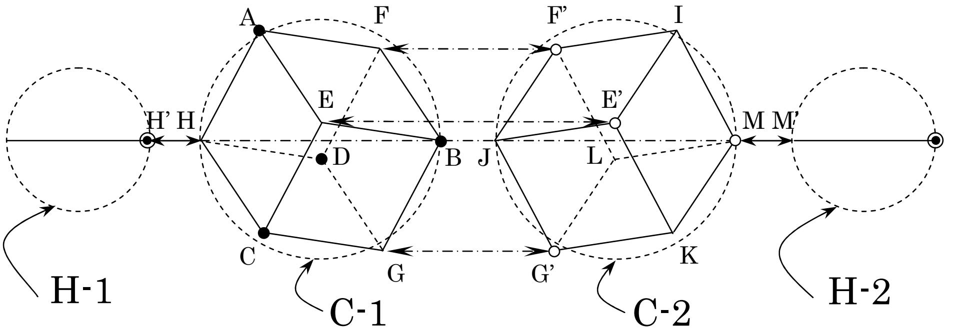


Fig. 41. Carbon and Hydrogen Atoms before Bonding (cubes seen from different angles for easy visualization . Atoms not to scale).

The 3 electrons of carbon-2, namely E', F' and G', fill the empty slots of carbon -1 at E,F, and G respectively. Hence, the triple bond. Hydrogen-1's electron H' attaches to carbon-1 at H, and hydrogen-2's empty slot is filled by carbon-2's electron M. In this manner, all of carbon-1's electrons are now paired, as well as that of hydrogen-2. When all of the electrons involved make half a revolution around their respective orbits, all of carbon-2's and hydrogen-1's electrons are now paired in turn.

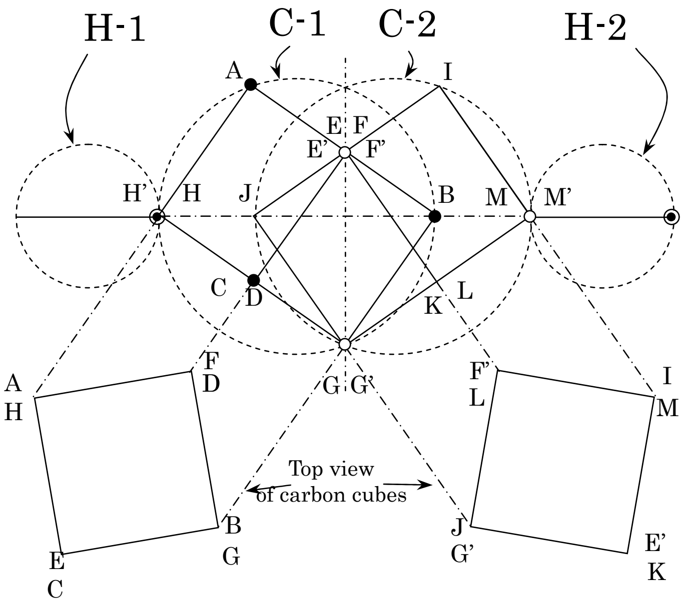


Fig. 42. Molecular Structure of Acetylene (as seen from the side and top. Atoms not to scale). Phase 1: Carbon-1 and Hydrogen-2 Paired.

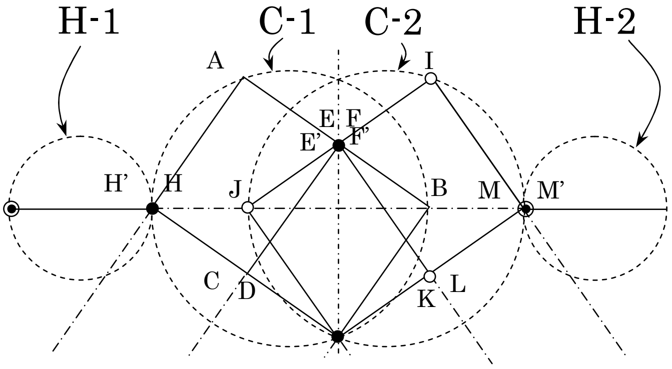


Fig. 43. Molecular Structure of Acetylene (as seen from the side. Atoms not to scale). Phase 2: Carbon-2 and Hydrogen-1 Paired.

As is evident in the diagram, the molecular structure of acetylene is linear. The 2 carbon atoms interpenetrate each other by the distance JB, which actually is the altitude of the tetrahedra ABCD and IJKL respectively. Simple geometric analysis, disregarding the forces of electron repulsion and nuclear attraction, reveals that each atom is penetrating 2/3 the diameter into the other and the length of the 2 carbons is 4/3 the diameter.

While acetylene is symmetrical along certain axes, it is not so along all axes. This asymmetry could account for the rotational spectra exhibited by acetylene [6].

2.8 Carbon Monoxide (CO):

The structural formula is: $:C\equiv O:$

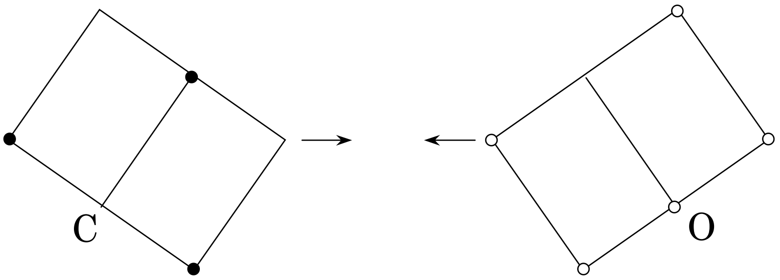


Fig. 44. Carbon and Oxygen Atoms before Bonding (as seen from the side).

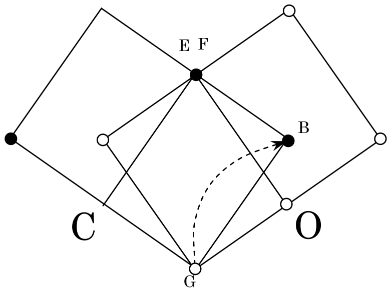


Fig. 45. Molecular Structure of Carbon Monoxide.
Phase1: 1 Electron of Carbon jumps from G to B to form a Lone Pair, and Carbon and Oxy-gen Triple-bond at E, F, and G. All Oxygen Electrons Paired.

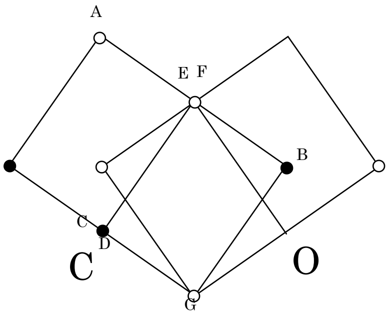


Fig. 46. Molecular Structure of Carbon Monoxide.
Phase 2: 1 Electron of Oxygen enters Carbon Orbit, and 1/2 Orbit Revolution makes 3 Bond-ing Pairs of AG, CF, and DE. All Carbon Electrons Paired.

2.9 Buckminsterfullerene (C-60):

C-60 is comprised of 60 carbon atoms arranged in R. Buckminster Fuller's geodesic system; hence, the name. The molecular configuration is of 12 pentagons and 20 hexagons as shown below:

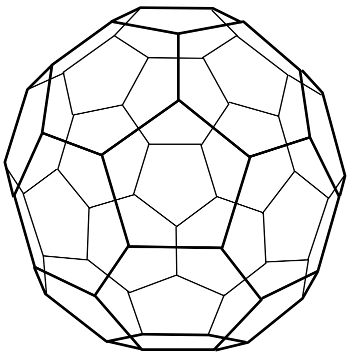


Fig. 47. Molecular Structure of Buckminsterfullerene (C-60).

Each atom is surrounded by 3 others with 2 bonding angles of 120 and 1 of 108 degrees. The 3 angles constitute 3 planes converging at the central atom, thus:

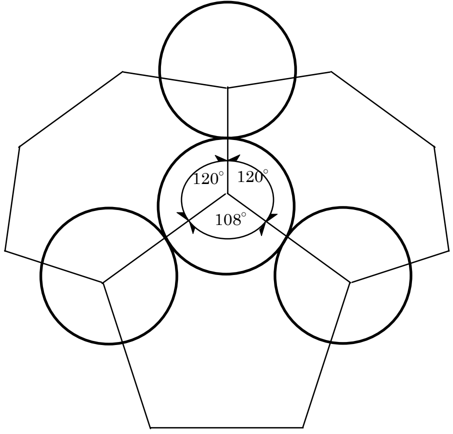


Fig. 48. The Bonding Angles and Planes of C-60.

The 4-electron configuration of carbon is tetrahedral with central angles of 109.5 degrees each. When carbon atoms attach to one another to produce C-60, each carbon's 3 empty slots in the tetrahedra are filled by the 3 neighboring atoms. However, in order to create the two 120 degrees angles and one 108 degrees angle of C-60 for each atom, the red orbit rotates just a bit about the x-x axis to displace the intersections of the blue with the red, and of the green with the red .

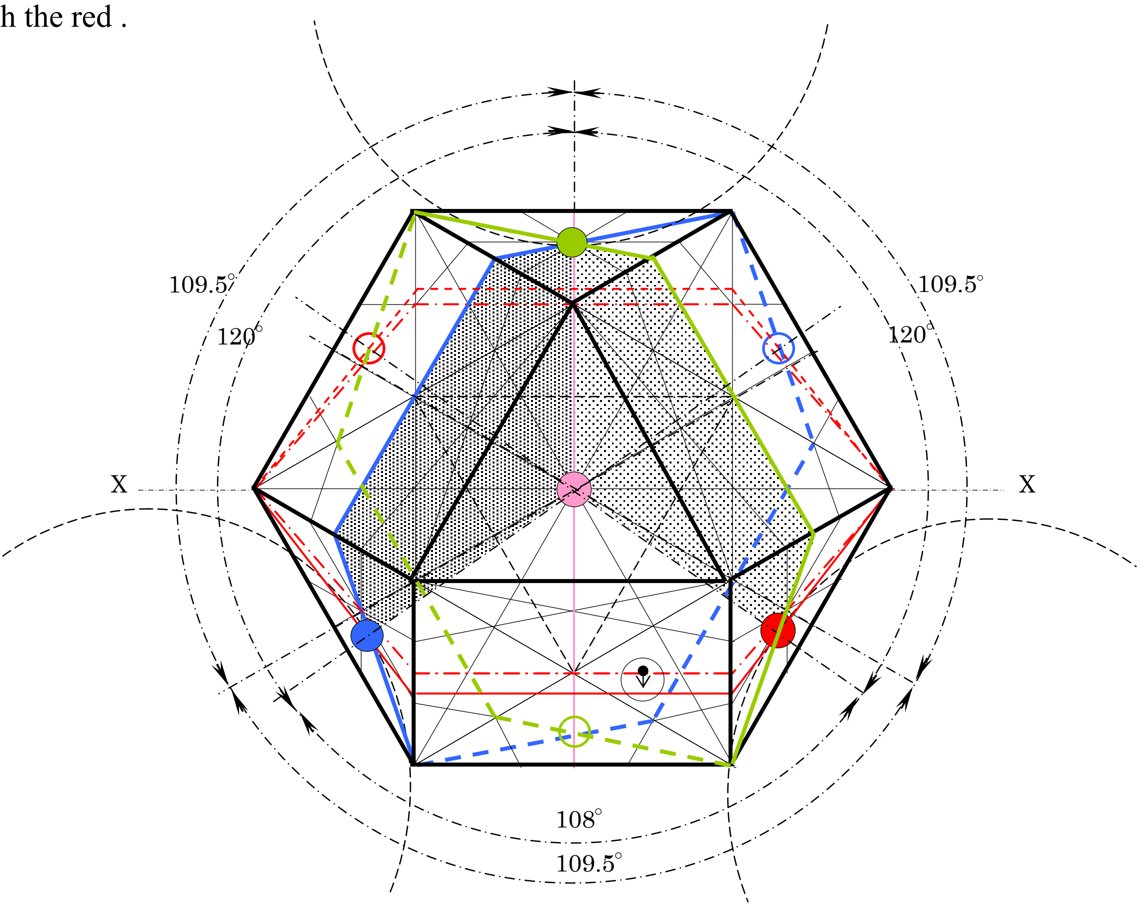


Fig.49. Red Orbit shifts to produce Angle Displacement (as seen from inside the molecule).

In this way, the 3 bonding angles are secured, while at the same time 3 of carbon's 4 electrons are paired. The remaining unpaired (pink) electron, since it traverses the intersection of the green and the blue, could thus be paired as well alternatingly.

With the cubes, the molecular arrangement is:

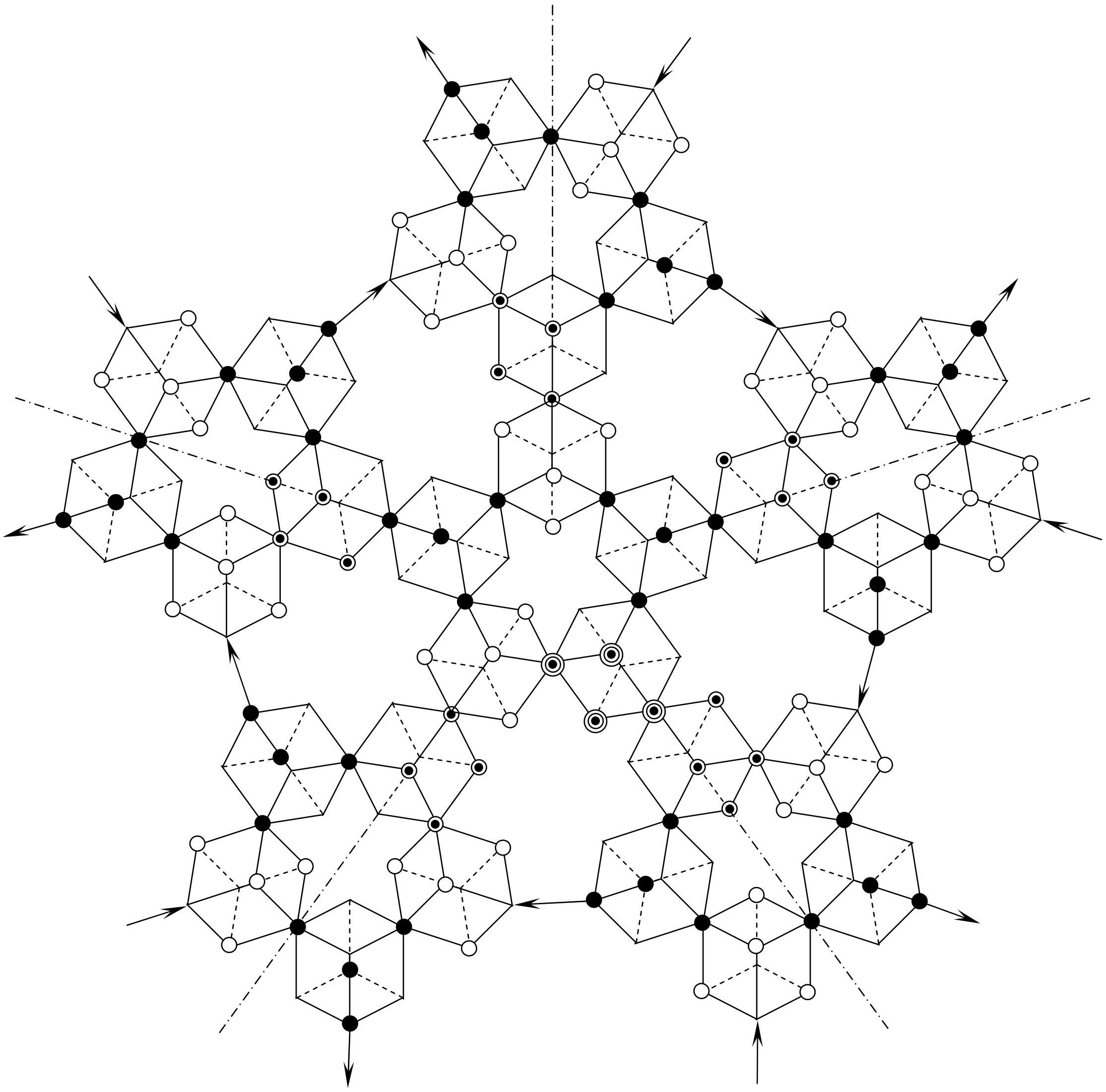


Fig.50. 1/2 Molecular Structure of C-60: Phase 1.

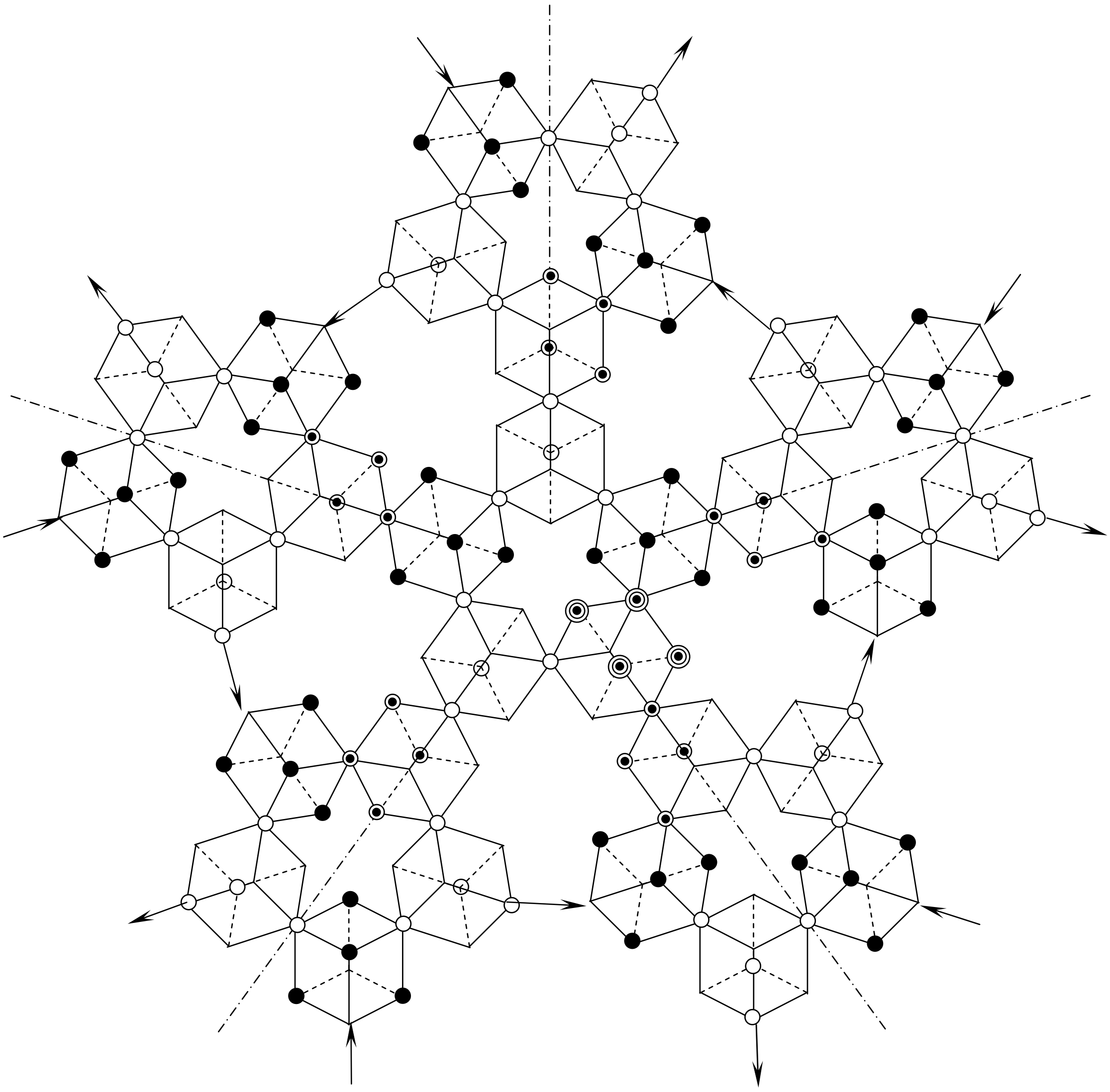
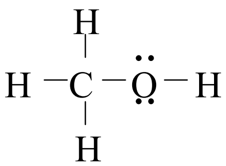


Fig.51. 1/2 Molecular Structure of C-60: Phase 2.

Four-fifths of the atoms alternate between tetrahedral and 7-electron configurations, while the rest alternate between either trigonal bipyramidal or octahedral and 7-electron configurations.

2.10 Methanol (CH_3OH):

Finally, a polyatomic molecule without a central atom shall be presented . The Lewis structure for methanol is :



$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{\overset{|}{\underset{|}{C}}}}-\ddot{\underset{\cdot\cdot}{O}}-H$$

Since carbon has 4 valence electrons with a tetrahedral arrangement, the 1 oxygen and 3 hydrogen atoms will occupy the 4 empty slots to complete the orbits of carbon and hydrogen respectively. Since oxygen has one unpaired orbit left to fill, the remaining hydrogen attaches to it to complete all the orbits of all the atoms involved. The oxygen's original 6-valence electron octahedral configuration adapts itself to double tetrahedra (or cube) as it attaches to the carbon and to the hydrogen . As oxygen completes its orbits thus by filling the unpaired slots of the tetrahedral arrangement, the molecular configuration is as follows:

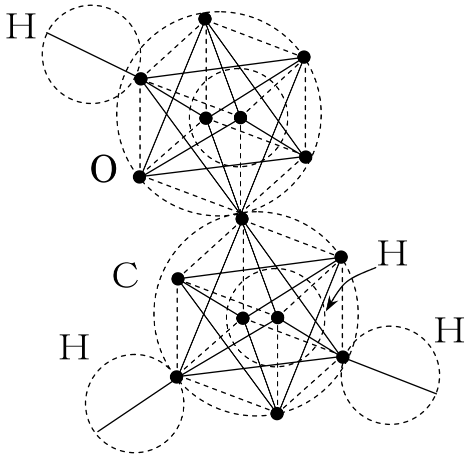


Fig. 52. Molecular Structure of Methanol (with carbon and oxygen orbits paired).

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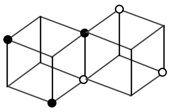
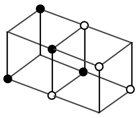
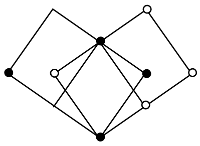
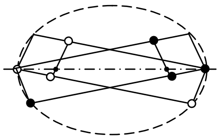
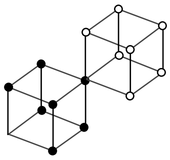
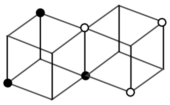
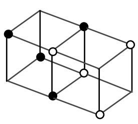
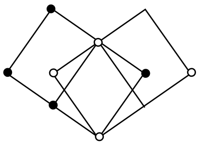
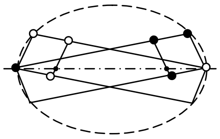
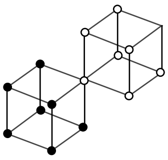
1. Fuller, R.B. *Synergetics* , Macmillan Publishing Co., Inc., New York, 164 (1975)
2. Zumdahl, S.S. *Chemistry,* D. C. Heath and Company, Toronto, 292 (1989)
3. Fuller, R.B. *Synergetics ,* Macmillan Publishing Co., Inc., New York, 372 (1975)
   Ingber, D.E. *Scientific American* 278, 30-39 (1998)
4. Zumdahl, S.S. *Chemistry*, D. C. Heath and Company, Toronto, 358 (1989)
5. Zumdahl, S.S. *Chemistry,* D. C. Heath and Company, Toronto, 359 (1989)
6. Aldersey-Williams, H. *The Most Beautiful Molecule*, Aurum Press Limited, London, 46 (1994)

Supplement 1.

Comparative table showing relationship of number of bonds, bond order, observed bond dis-sociation energy, bond length, and depth of interpenetration of homonuclear diatomic mole-cules B_2 through F_2 :

	B_2	C_2	N_2	O_2	F_2
Lewis structure*	·B = B·	C≡C	:N≡N:	·Ö−Ö·	:F̤̈−F̤̈:
Phase1*					
Phase2*					
Magnetism	Paramag-netic	Diamag-netic	Diamag-netic	Paramag-netic	Diamag-netic
Number of bonds*	2	4	3	2	1
Bond order	1	2	3	2	1
Observed bond dissociation energy (kj/mol)	290 (≒154x2)	620 (≒154x4)	942 (≒154x6)	495 (≒154x3)	154
Observed bond lengh (A)	1.59	1.31	1.10	1.21	1.43
Calculated bond length (A)*	1.43	0.89	0.47	* *	1.28
Calculated depth of interpenetration (A)*	0.33 simple penetration	0.66 simple penetration	0.93 complex penetration	* * complex penetration	0.00

* Propositions of the new model.   ** See explanation on O_2.

From the table, it could be concluded that bond dissociation energy is directly proportional to number of bonds and depth of interpenetration of the atoms and inversely proportional to internuclear distance. In other words, bond energy is dependent on how atoms and their electrons are geometrically related. For example, given that F_2 is singly bonded and has dis-sociation energy of 154 (kJ/mol), then energy of doubly bonded B_2 should be roughly twice 154, or 308, which closely corresponds with observed 290. We could then predict that quadruply bonded C_2 is roughly 4 times 154, or 616, which closely corresponds with observed 620. Calculated interpenetration of C_2 is 0.66A, which is 2 times 0.33A of B_2. Hence, we could test the calculated energy by another way by multiplying 290 by 2, which equals 580, and see that it again is close to observed 620. Triply bonded N_2 then should be about 3 times 154, or 462, but the result does not agree with observed energy. This is because the type of geometrical bonding here is quite complex and interpenetration deep (1.33 of atomic radius, or 0.93A) that the bond energy is much greater than the simple multiple of the singly bonded energy. If we work backwards, however, by comparing that the bond energy for N_2 is roughly 1.5 times that of C_2 , and multiply the calculated depth of interpenetration of C_2 of 0.66A by 1.5, we obtain 0.99A, which is close to the calculated interpenetration of N_2 of 0.93A.

O_2 .

Some possibilities of O_2 bonding are the following:

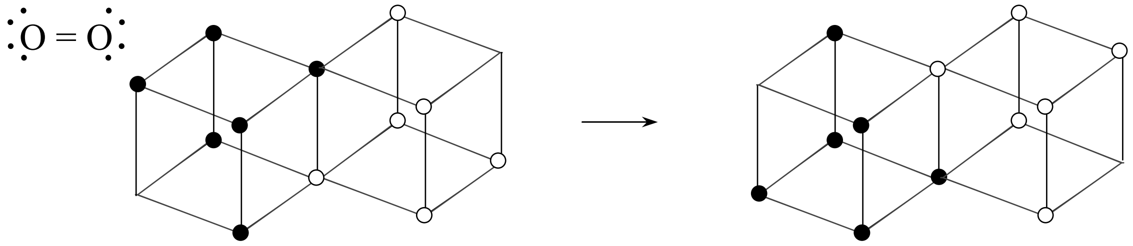


Fig. S1-1. 2-Phase Diagram for O_2 : Alternative 1.

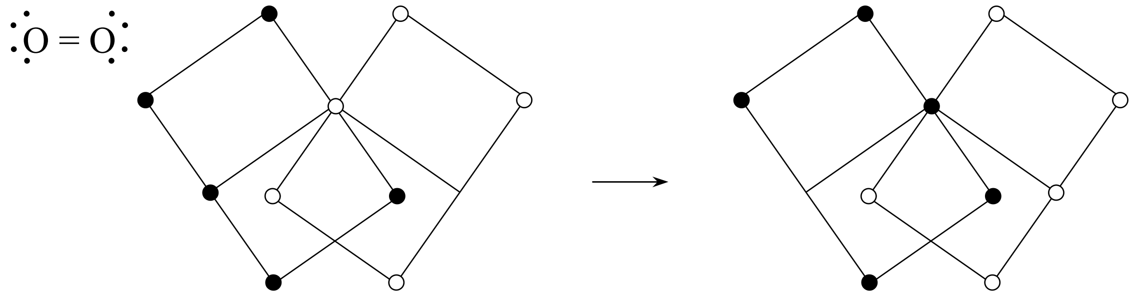


Fig. S1-2. 2-Phase Diagram for O_2 : Alternative 2.

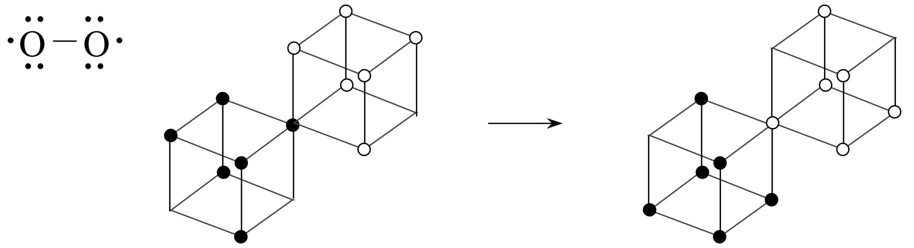


Fig. S1-3. 2-Phase Diagram for O_2 : Alternative 3.

However, since O_2 is observed to be paramagnetic with 2 free electrons, alternatives 1 and 2, being diamagnetic, are ruled out.

Alternative 3, being paramagnetic with 2 free electrons, is a possibility. However, considering the relatively large bond dissociation energy observed, the single bond together with great repulsion amongst the 12 electrons, make it a very unlikely candidate. Hence, a bit unusual type of bond is here postulated that is somewhat counterintuitive to the generally observed cases. Perhaps, however, it is Nature's scheme to possess such a molecule as vital as O_2 that is stable and yet flexible (in terms of bonding with other elements) by leaving 2 electrons free to pair. This particular molecular structure, unlike any other thus far presented, is di-nuclear, i.e., has 2 nuclei around which all electrons orbit. In other words, electrons orbit an ellipsoidal region of space with 2 foci.

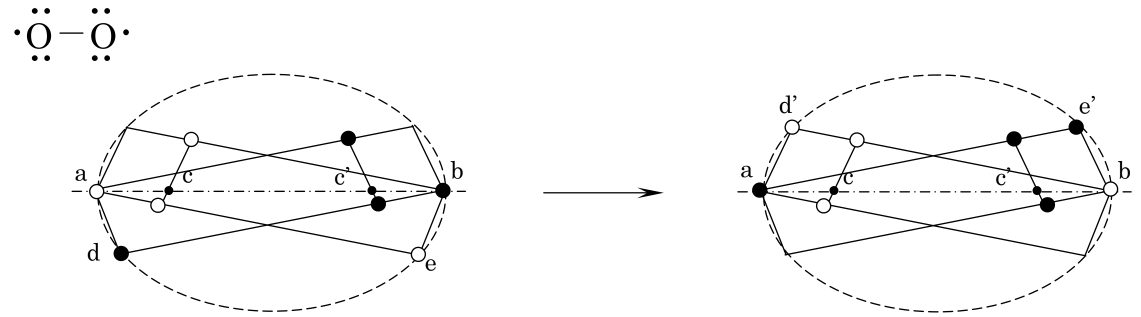


Fig. S1-4. 2-Phase Diagram for O_2: Alternative 4.

As can be observed in the diagram, the "cubes" are stretched out with ellipsoidal foci, or nuclei, at c and c' respectively. A single bond is formed between 2 joints at a and b, with 2 free electrons at d and e, and alternatingly at d' and e'.

Supplement 2

Ethylene (C_2H_4) : Alternative.

While the proposed model satisfies the planar arrangement of atoms in the ethylene molecule, it also predicts a nonplanar version. This fact had for some time been puzzling the author as well as receiving criticism from reviewers of the paper. The author is happy to relate that evidence for this occurrence had been reported in a paper written in 1974 by Foo and Innes[1]. Accordingly, it had been observed that when energy is applied to ethylene the planar arrangement of the atoms change. It is postulated here that the new arrangement is as follows.

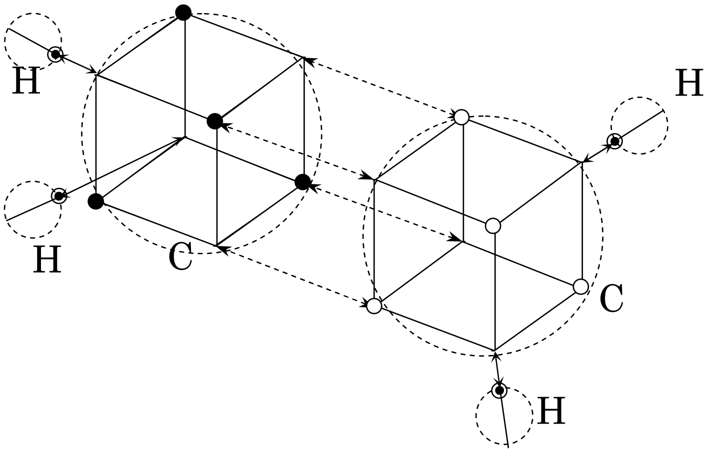


Fig. S2-1. Carbon and Hydrogen Atoms before Bonding (atoms not to scale).

Final arrangement is thus:

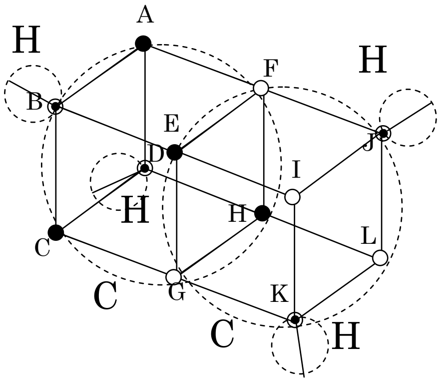


Fig. S2-2. Carbon and Hydrogen Atoms after Bonding (atoms not to scale).

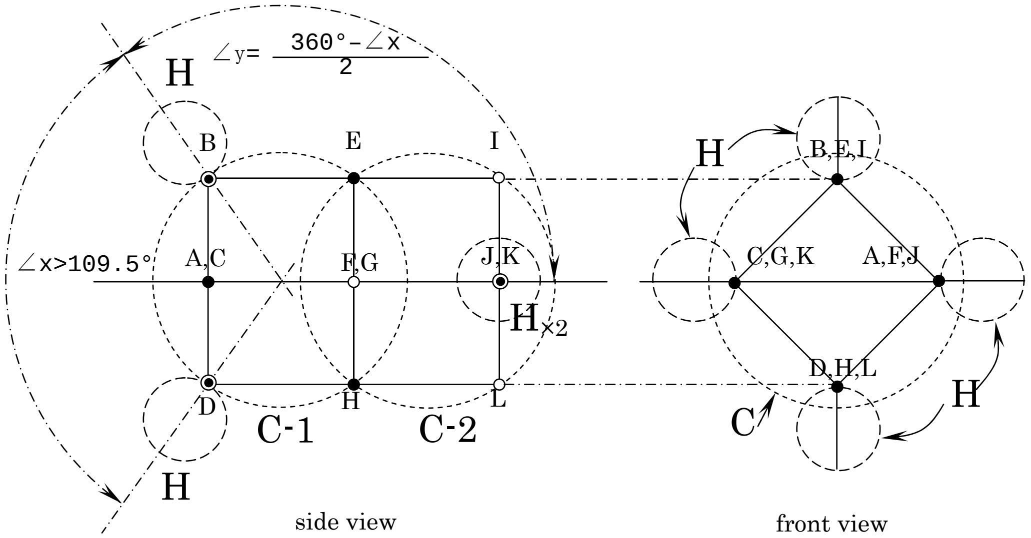


Fig. S2-3. Molecular Structure of Ethylene (C_2H_4): Alternative Phase1: All of C-1 and C-2 Atoms Paired (atoms not to scale).

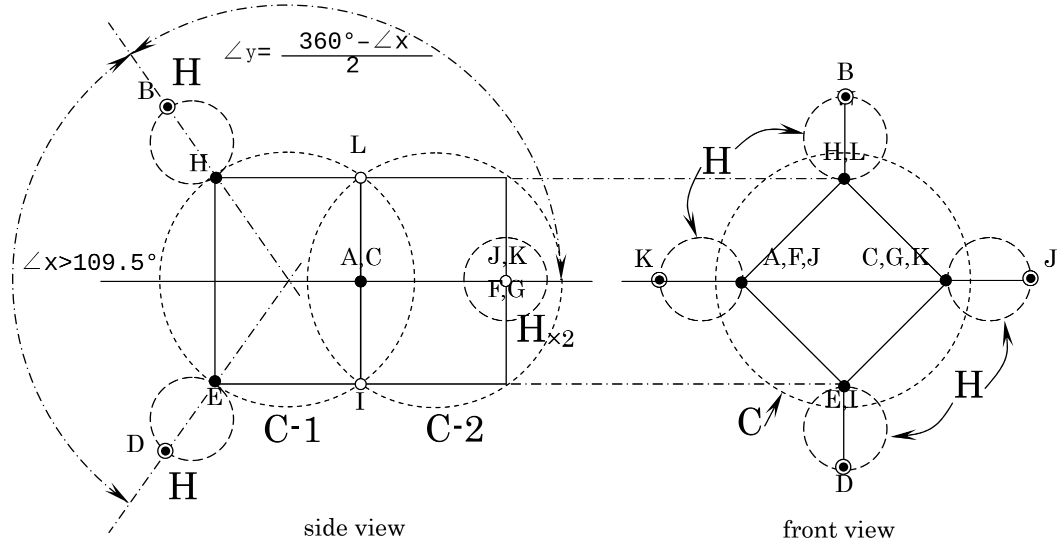


Fig. S2-4. Molecular Structure of Ethylene (C_2H_4): Alternative Phase 2: All of Hydrogen Atoms Paired (atoms not to scale).

As shown, the new arrangement has a pair of hydrogen atoms rotated 90 degrees in relation to the other pair. It is thought that when energy is applied to the hydrogen atoms, their electrons respectively jump to the next larger shell such that electron repulsion is increased between those hydrogen atoms on either side of the 2 carbon atoms. Therefore, one pair of hydrogen atoms rotate 90 degrees such that inter-nuclear distance is increased and hence electron repulsion minimized.

Reference for Supplement 2

1. Foo, P.D., Innes, K.K. *Journal of Chemical Physics* 60-11 (1974)