

Atoms connected in molecules by electronic bonds

S. Sarg

Selected material from BSM thesis:
(www.helical-structure.org)

Note: The numbers of the figures and equations shown in square brackets match the numbers in BSM thesis.

Short introduction: The known physical laws and postulates are obtainable if the classical empty space is filled by unique material structure. A model called a Cosmic Lattice (CL) is suggested according to which the vacuum possesses an underlying structure built of two types super dens sub-elementary particles arranged in nodes. These particles called twisted prisms are from two different intrinsic matter substances. In empty space the prisms of same type are attracted by forces inverse proportional to the cub of the distance. The nodes are with flexible geometry and possess energy wells. The CL space exhibits quantum features and creates conditions for fields: gravitational, electrical and magnetic. It is also responsible for the constant light velocity, the relativistic effects and the inertia. The elementary particles are complex helical structures built of twisted prisms in a unique process of crystallisation. The protons and neutrons in the atomic nuclei follow a strict order. The suggested physical models are successfully applied for explanation of dozens of physical effects and phenomena in a large range from micro to macro Cosmos.

The unveiled structure of the electron is shown in Fig. 1. It is a 3 body oscillation structure consisting of central core (from a right hand twisted prisms) internal helical structure (left hand twisted prisms) and external helical structure (right hand twisted prisms). The both helical structures possesses internal lattices from same type of prisms, that are more dense of the CL space. The lattice of most external structure modulates the CL nodes and creates the electrical field of the electron. The internal helical structure and the central core and are centred by the IG field and oscillates in conditions of ideal bearing.

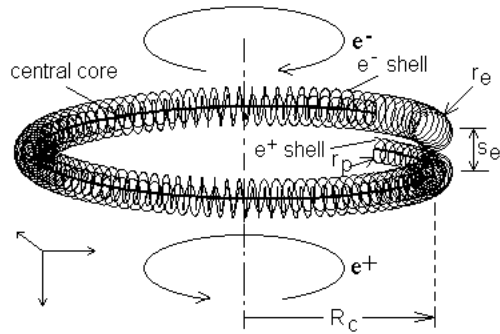


Fig. 1
Oscillating electron

The confined screw like motion of the oscillating electron in Cosmic Lattice (CL) space is characterized by strong quantum interactions with the oscillating CL nodes. They are related to the phase matches between the complex cycle of the electron and the Compton wavelength, that is one of the major CL space parameter. As a result, the electron moves at preferred velocities corresponding to the energy set: 13.6 eV, 3.4 eV, 1.51 eV, 0.85 eV and so on. The quantum effect of motion for energy above 13.6 eV is much weaker.

The characteristic parameters of dynamical interactions of oscillating electron are shown in Table 1.

Table 1

| No | E (eV) | V_{ax} | V_t | r_{mb_eq} | l_{ql} | L_q (A) |
|----|----------|--------------|-------|--------------|--------------|-----------|
| 1 | 13.6 | αc | c | $\sim R_c$ | $2\pi a_0$ | 1.3626 |
| 2 | 3.4 | $\alpha c/2$ | $c/2$ | $2R_c$ | $2\pi a_0/2$ | 0.6813 |
| 3 | 1.51 | $\alpha c/3$ | $c/3$ | $3R_c$ | $2\pi a_0/3$ | 0.4542 |
| 4 | 0.85 | $\alpha c/4$ | $c/4$ | $4R_c$ | $2\pi a_0/4$ | 0.3406 |
| 5 | 0.544 | $\alpha c/5$ | $c/5$ | $5R_c$ | $2\pi a_0/5$ | 0.2725 |

where: E - is the electron energy, V_{ax} - is the axial velocity, V_t - is the tangential velocity of the rotating electron structure, r_{mb_eq} - is the equivalent value of the boundary electron magnetic radius in plane normal to V_{ax} vector, c - is a light velocity, R_c - is the Compton radius, a_0 - is the Bohr radius, l_{ql} - is the trace length of the electron's motion in a closed loop (single quantum loop), L_q - is the length size of the quantum loop as Hippoped curve with a parameter $a = \sqrt{3}$.

Figure 2 shows the spatial geometry of the Deuteron, where: p - is the proton and n - is the neutron. The neutron is centred over the proton saddle and kept by the Intrinsic Gravitation (IG)

field and the proximity electrical fields of the neutron and proton. In such conditions the neutron is kept stable (it could not be unfolded and converted to a proton).

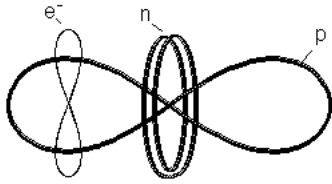


Fig. 2. Deuteron with electron in Balmer series according to BSM physical model

Fig. 3 illustrates the protons and neutrons arrangement in the nucleus of He. In such close distance the internal lattices of the proton's helical structures are kept by IG forces that are inverse proportional to the cube of the distance. The He nucleus is the most compact atomic structure. So its influence on the CL space parameters is strongest. As a result the helium nucleus possesses the largest binding energy between the involved protons and neutrons..

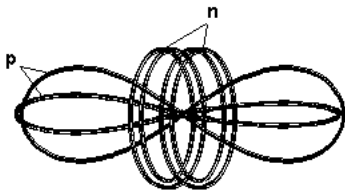


Fig. 3. Helium nucleus according to BSM physical model

When taking into account the two features of the proton: a finite geometrical size and the distributed proximity electrical field it is evident that the Coulomb law is valid down to some limit, defined by the finite size of the proton structure. This is verified by the model of Balmer series in Hydrogen presented in Chapter 7. The idealized shape of Balmer series orbit is shown in Fig. [7.7].

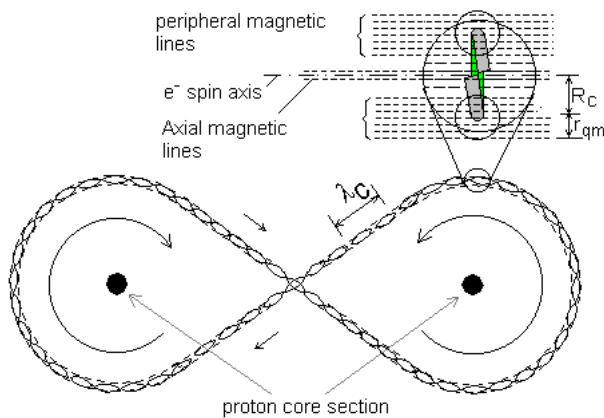


Fig. [7.7]. Idealized shape of Balmer series orbit. R_c - is the Compton radius, r_{qm} - is a magnetic radius of electron at sub-

optimal quantum velocity. The compton wavelength λ_c is not in scale for drawing clarity.

Fig. 4 shows the patterns used for the proton, deuteron, tritium and helium, while the right part shows the most common shapes of the quantum orbits. The dimensions of the quantum orbits and the proton and neutron are given in one and a same scale.

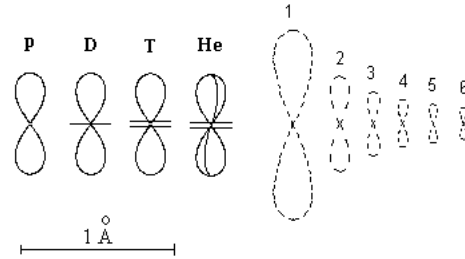


Fig. 4

Patterns for simple elements and quantum orbits

Polar axis can be identified in any atomic nucleus. It is defined by the long symmetrical axis of one or more He nuclei in the middle of atomic nucleus. The atomic nuclei possess also twisting features due to the proton twisting (not shown in the drawings). In the Atlas of ANS additional symbolic notations are used for the unveiled types of protons bonding and pairing in which IG (Intrinsic Gravitation) and EM fields are involved. It is evident from the nuclear structure that the positions of the electron orbits are strictly determined by the protons positions with their proximity electrical fields and the conditions of quantum orbits provided by Table 1. **So the electron orbits are not shown in the Atlas of ANS but their positions are easily identifiable. Having in mind the above consideration the well defined orbital positions are characterized by the same first ionization potential known experimentally and embedded in the Quantum mechanical models.**

3. Electronic bonds between atoms in molecules

It is evident that the BSM model of the atom allows identification of the orbital planes and chemical bond orientation of the atoms in the chemical compounds. Additionally the quantum mechanical spin of the electron circling in orbit around the proton is also identifiable. The proton envelope is twisted torus, so it possess a helicity. If the electron in the orbit shown in Fig. 2 circling in two different direction in respect to the proton helicity, the two type of energy interactions are charac-

terized by slightly different energies. This corresponds to line doubling in the atomic spectra.

The intrinsic conditions of the quantum orbits defined by the two proper frequencies of the electron and CL node dynamics are valid also for the bonding electrons in molecules. Fig. [(19.2)] shows the Structure of the most simple H₂ molecule identified as ortho-I state.

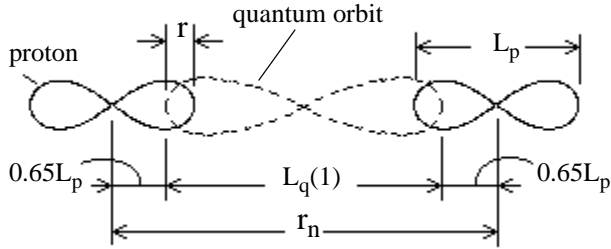
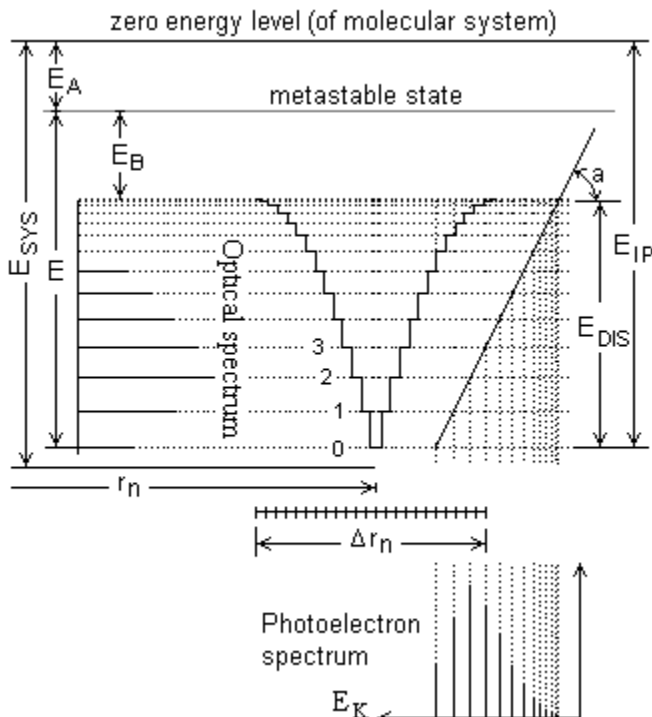


Fig. [9.12] Structure of H₂ - ortho-I state molecule
 L_p - is a proton length
 $L_q(1)$ is a long side of first harmonic quantum orbit
 r_n - is the distance between the Hydrogen atoms
 r - distance between the electron and the proton

core in the circular section (most external) of the orbital trace
Note: The quantum orbit quasiplane does not coincide with the quasiplanes of the protons. It passes through the locuses of the proton clubs.

Figure [(9.15)] shows the vibrational diagram of H₂ - ortho-I state molecule and the relation between the optical and photoelectron spectrum.



[Fig. 9.15.] Vibrational levels of H₂ ortho-I and their

relations to the optical and photoelectron spectra

E_{DIS} - is known as a dissociation energy (although it may not lead to dissociation of transitions are between the energy levels and the metastable state see J. H. Black and A. Dalgarno, 1976)

E_A and E_B energies defining the position of the metastable state).

E_K - is a PE spectrum parameter ("electron kinetic energy")

1,2 3 - vibrational bands

In analysis the IG field energy is presented as integration of IG forces from some initial value to infinity. Practically the integration does not go to infinity because in case of inverse cubic law the field strength falls vary fast with the distance.

$$E_{IG}(CP) = -2 \int_{r_{ne}}^{\infty} \frac{G_o m_{po}^2}{r^3} dr = \frac{C_{IG}}{(L_q(1) + 0.6455L_p)^2} \quad [(9.13)]$$

where: m_{po} is the Intrinsic mass of the proton,
 G_o is the intrinsic gravitational constant

$$C_{IG} = G_o m_{po}^2 - \text{IG factor}$$

Note: The factor 2 in front of the integral comes from the two arm branches (along abcd axes) of the CL space cell unit. They both are included in the xyz cell unit to which all the CL space parameters are referenced. All equations using C_{IG} factor in the following analysis confirms the need of factor 2.

The vibrational motion of the simple H₂ molecule is analysed based on the total energy balance in which the energy of IG field is a major component. The total momentum energy balance at the equilibrium point is given by

$$\frac{C_{IG}}{q(L_q(1) + 06455L_p)^2} = \frac{2E_q}{q} + \frac{2E_K}{q} \quad (\text{eV}) \quad [(9.18)]$$

where: $2E_q/q = 511 \text{ KeV}$ - is the energy of the two electrical charges (for two protons);
 $2E_K/q = 2 \times 13.6 \text{ eV}$ - is the kinetic energy of the two electrons.

The analysis unveils the vibrational states and one metastable state of H₂ ortho-I molecule. The obtained expression for the vibrational levels of this molecule with good for accuracy for their identification is:

$$E_v = \frac{C_{IG}}{qr^2} - \frac{2E_q}{q} - \frac{2E_K}{q} + E_X \quad (9.23)$$

$$r = [[L_q(1)](1 - \pi\alpha^4(v_m - v)^2)] + 0.6455L_p \quad (9.23.a)$$

The photoelectron and optical spectrum are analysed and the corresponding transitions and vibrational levels are identified. The calculated vibrational levels are compared to those identified from the optical spectrum. The calculated vibrational curve fits quite well to these levels after adjusting a small offset level corresponding to E_X , whose value is 6.26 (eV). It is likely a constant from the integration in Eq. [(9.13)] that influences slightly only the vertical position of the vibrational curve. The influence of this parameter on C_{IG} , however, is intrinsically small (beyond 5 significant digit), so for the number of tasks it could be omitted. Therefore, Eq. [(9.18)] allows determination one very useful parameter of IG field - the factor C_{IG}

$$C_{IG} = (2hv_c + hv_c\alpha^2)(L_q(1) + 0.6455L_p) \quad [(9.17)]$$

$$C_{IG} = G_0 m_{n0}^2 = 5.2651 \times 10^{-33}$$

Fig. [9.24] shows simultaneously the vibrational energy levels E_v , calculated by Eq. [(9.23)] and those estimated from the optical transitions $E(0-v'')$ and $E(1-v'')$ in UV spectrum (Lyman system) provided by I. Dabrowsky (1984). More details about identification of the transitions are given in §9.6 in Chapter 9 of BSM. The fractional error between calculated levels and experimental data is in a range of +/- 0.035%. While the vibrational curve is usually drawn as energy level towards internuclear distance, the step-like curve is an energy level towards a vibrational quantum number. The obtained value of energy difference between the smallest and largest vibrational number is 4.4834 eV, pretty close to the experimentally obtained value of 4.478 eV.

The analysis indicates that the total energy balance according to Eq. [(9.18)] is kept very accurate, despite the large IG energy. Therefore:

The emission or absorption of a photon is a result of comparatively small disturbance of the total energy balance.

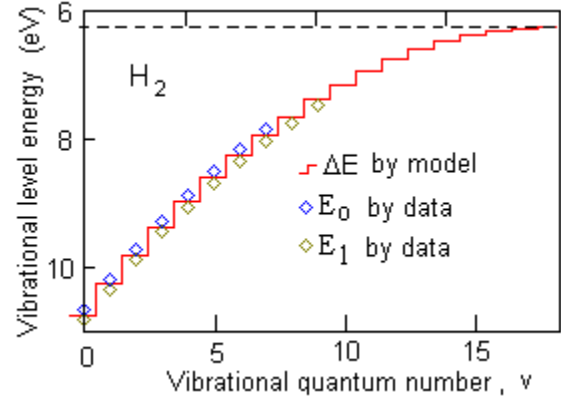


Fig. [9.24]. Energy levels E_v , (eV) calculated by Eq. (9.23) towards the vibrational levels for H2 - ortho. The calculated levels are shown by step line, while the optical transitions corresponding to two different QM spins are shown by diamonds.

Similar analysis is provided also for D_2 molecule since it is a more typical building element in the atomic nuclei.

Applying a total energy balance analysis for diatomic molecules an approximate expression for vibrational levels, ΔE of homonuclear molecules is obtained (BSM, Chapter 9, §9.15.2) It is approximate because the participated IG mass of the atomic nucleus is considered located in a point. In number of cases, however, the accuracy is enough for determination of the possible quantum orbit from the set of available quantum orbits. For this purpose a direct expression of internuclear distance of diatomic homonuclear molecule is derived from a conditions of total energy balance.

$$r_n(n, A, p) = (A - p) \sqrt{\frac{2\alpha C_{IG}}{pE_B(n)}} \quad (9.56)$$

$$E_B(n) = \frac{C_{IG}}{[L_q(n) + 0.6455L_p]^2} - hv_c \left(2 - \frac{\alpha^2}{n} \right) \quad (9.56.a)$$

where: $E_B(n)$ - is a total energy involved in the bond connection of pair valence protons (deuterons), A - is the atomic mass for one atom in *daltons* (atomic mass units), p - is the number of protons involved in the bonding system (also per one atom), n - is the subharmonic quantum number of the quantum orbit, r_n - is the internuclear distance at the equilibrium vibrational point.

The quantum orbit could contained not only one but more quantum loops (see §7.4, Chapter 7 of BSM). In such case Eq. (9.56) and (9.56.a) obtains modifications, discussed in §9.15.3 of Chapter 9 of BSM

It is found that the first harmonics quantum orbit $L_q(1)$ is possible only for H_2 and D_2 molecules. For diatomic molecules from heavier atoms the intrinsic balance is obtained only for larger sub-harmonics of the rotating and oscillating electron (corresponding to lower quantum velocities of the electron), or $L_q(2)$, $L_q(3)$, $L_q(4)$ and so on. Based on derived Eq. [9.23] and the data from optical and photoionization spectra the possible configurations of simple diatomic molecules are identified. Fig. [9.42] shows the photoelectron spectra of O_2 molecule. They corresponds to different internuclear distances..

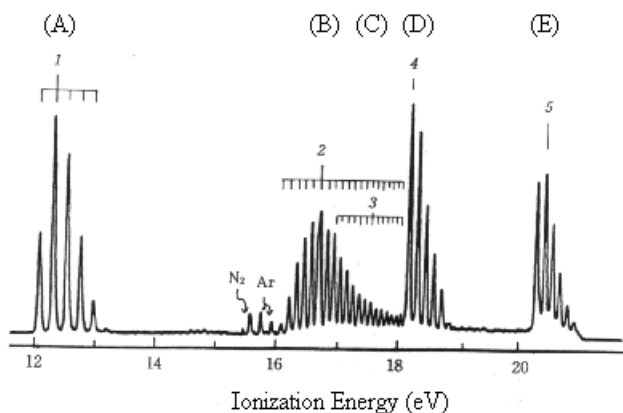


Fig. [9.42]. PE spectrum of oxygen molecule excited by He I radiation (Turner et al., courtesy of K. Kimura et al., (1981))

Table 9.6 shows the calculated antinuclear distances for different quantum orbits L_q using Eq. [9.42] and the estimated distances by the drawing method, using the known dimensions of the proton (neutron) and the quantum orbit from the possible set of quantum orbits. The proton and neutron dimensions are estimated by cross-analysis. The proton envelope volume is involved in the theoretical estimation of the background temperature of CL space (2.72 K) (Chapter 5) and in the proton mass balance analysis (Chapter 6). The proton core length is cross-validated by the Balmer series model and vibrational models of the molecules (Chapter 9). Table 9.6 shows also the corresponding possible state denoted by capital letters in bracket (BSM notation).

Calculated by Eq. (9.55) values for r_n for O_2 states. The values are given in Angstroms (A). **Table 9.6**

| r_n (A) | $L_q(2)$ (1 bond) | $L_q(2)$ (2 bonds) | $L_q(2x)$ (2 bonds) | $L_q(3)$ (2 bonds) |
|----------------|----------------------|-----------------------|------------------------|-----------------------|
| calculated | 2.57 A | 1.698 A | | 1.219 A |
| match drawing | 2 A | 1.7 A | 1.74 A | 1.25 A |
| possible state | {B}, {C} | {D} | {E} | {A} |

The considered electronic type of chemical bonds allows vibrational type motion of the involved nucleus. The rotational components in the vibrational rotational spectra are result of distortion of the electronic orbits. The possible distortions of the bonding orbit are two:

- symmetrical distortion
- asymmetrical distortion

The both type of distortion are shown respectively in Fig. 9.16, a. and b.

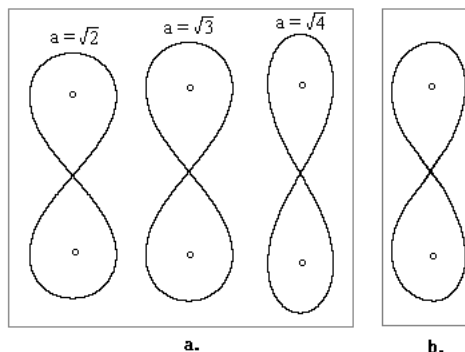


Fig. 9.16

a. - symmetrical and b. - asymmetrical distortion of the bonding orbit

The symmetrical distortions contributes to the rotational components of the optical spectra with not folded branches. The asymmetrical distortions contribute to the spectra containing folded branches. All the atomic nuclear structure possess polar twisting. In confine motion in CL space they rotates. This rotation contributes to the pure rotational spectra.

The molecular vibrations are characterized by additional effect not existing in the atoms. The IG forces are able to modulate the spatial configuration of the proximity E-field of the protons involved in the chemical bond. As a result the

vibrational quantum conditions occur at intrinsically small changes of the internuclear distance. For H₂ ortho-I molecule, for example, the vibrational range is only 4E-16 (m) while the internuclear distance is 2.23E-10 (m). This effects in fact facilitates the unveiling of the possible configuration of any the molecule, because it allows using the estimated dimensions of $L_q(n)$. From the energy point of view $L_q(n)$ are valid for the limit orbits. **But the intrinsically small change of the internuclear distance allows to apply them in the drawing method for unveiling the internuclear distances.**

4. Examples of some molecular structures

Note: In the following drawings the protons and neutrons in the central polar section of the atomic nucleus are only shown.

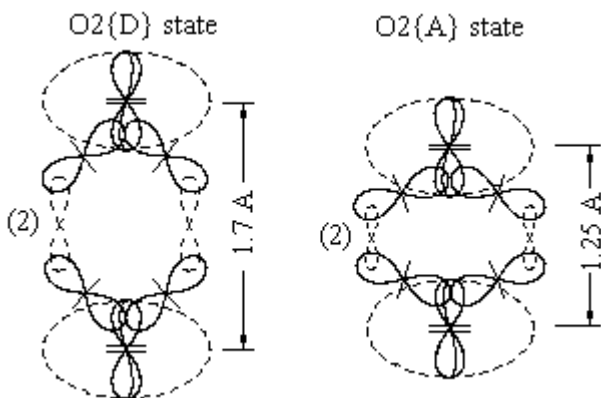


Fig. 9.43 Possible configurations of O₂(D) and O₂(A). {D} and {A} are states of O₂ according BSM model. The orbital planes of electrons does not lie in the drawing plane, but are shown in this way for convenience. The number in bracket indicates the subharmonic number of the quantum orbit.

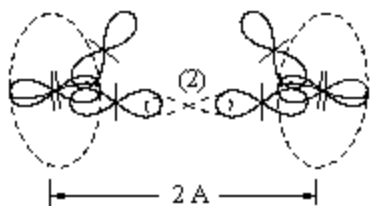


Fig. 9.44 Possible configuration of O₂ in {B} state

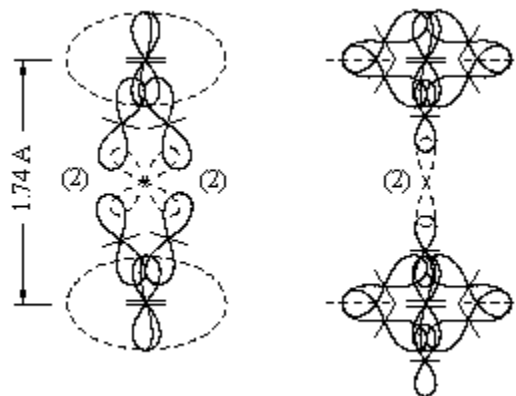


Fig. [9.45] Possible configuration of O₂ molecule in {E} state

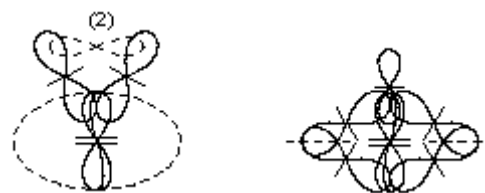


Fig. 9.53 Two views of the possible configuration of oxygen atom in Airglow state responsible for line emissions at 5577 Å and 6300 Å.

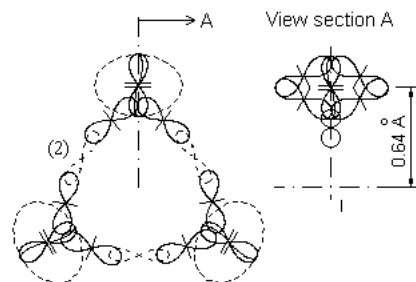


Fig. 9.53.A

Ozone molecule with second subharmonic bonding orbits. Every one of three bonding orbits contains two electrons with opposite quantum mechanical spin

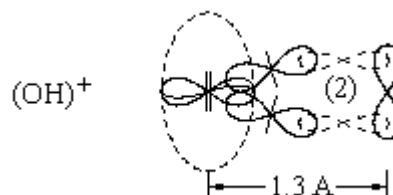


Fig. 9.54

Possible configuration of (OH)⁺ (the planes of

bonding orbitals are shown rotated at 90 deg, but in the real physical model, they are normal to the drawing plane)

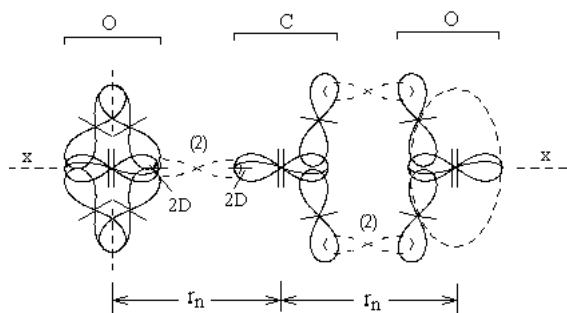


Fig. 9.56

One view of CO₂ molecule. The oxygen atoms look differently in both ends because the right-side one is rotated at 90 deg around the *xx* axis in respect to the left-side one.

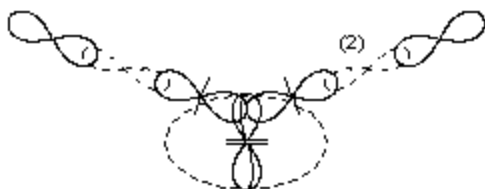


Fig. 9.59

Water molecule

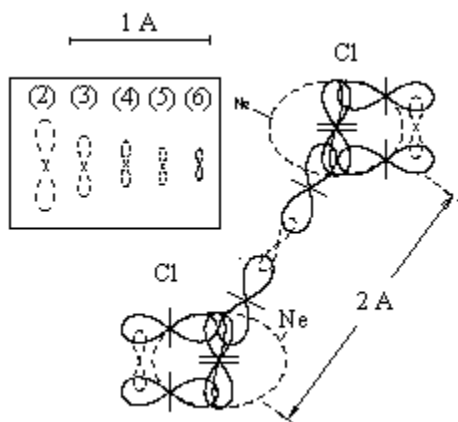


Fig. 9.7 Cl₂ molecule. The dashed oval is the envelope of Ne nucleus. The set of possible quantum orbits are shown in the square box, the number in bracket is the subharmonic number of electron quantum velocity. The experimental value of internuclear distance between Cl atoms is 1.98 A.

6. References

1. Sarg, S., Basic Structures of Matter (thesis on matter, space and time), Electronic collection in National Library of Canada: ISBN 0-9730515-0-7
http://collection.nlc-bnc.ca/100/200/300/stoyan_sarg/basic_structures_of_matter/index.htm
 Temporally available also in: www.helical-structures.org
2. Sarg, S., Atlas of Atomic Nuclear Structures, Electronic collection of National Library of Canada: ISBN 0-9730515-1-5
http://collection.nlc-bnc.ca/100/200/300/stoyan_sarg/atlas_of_atomic_nuclear/index.htm
 Temporary available also in www.helical-structures.org