

Charge Interaction as a Problem of Two States

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“Don’t believe your eyes, for the whole world is an illusion.” – Unknown

Abstract text.

1. Introduction

As a theoretical physicist, I have always studied the fundamental forces of nature. While my son was taking general chemistry in college, his freshman year, I took a glance at the text book which he was using. In it was described most of what we learn in high school and college regarding general chemistry. When I flipped through to sections regarding ionic bonding I decided to delve further. What was written in the book and what is accepted in chemistry today is that ionic bonds are the result of Coulomb’s force between opposing charges. If you take a simple salt, NaCl, and calculate the bonding force using Coulomb’s law:

$$\vec{F} = \frac{q_1 q_2}{4\pi\epsilon_0} \frac{\hat{r}}{r^2} \quad (1)$$

Proceed to do the same thing for another simple salt, KCl, and you will find that values should be quite similar; the only real difference is a change in the radius you use by mere nanometers. However, the actual bonding force is much different then what you calculate using this simple formula. I asked myself, are salts held together by Coulomb’s potential? And what do we even mean by Coulomb’s force? Does it even exist? Try using Coulomb’s logic to explain why in nature you will never find monatomic hydrogen. If you follow logic, the non-existantance of monatomic hydrogen in nature is a complete contradiction of Coulomb’s law. What led me to study this aspect of physics and chemistry was the question what interaction, if any, exists between opposing charges, and can it be described as a problem of two states? The pursuit for an answer to this question gave me great pleasure, but lead to many new questions, especially regarding the state of general chemistry today. All of general chemistry today is built on the concept of the electromagnetic field, but one has to come to terms and realize no such fields exist. All natural forces are the result of interactions, and the sum and combination of various interactions. With this paper I hope to open the minds of chemists and physicists specifically regarding their understanding of chemical bonding and “electromagnetic interaction”.

2. Elementary Dipole

We start off by examining a closed system where you have two particles, a proton and an electron, as a quantum system because we are only looking at the interaction of the two charges.

The coordinate of the one of the particles will be X_1 and the coordinate of the second particle will be X_2 , the point X' will lie in between the points X_1 and X_2 at distance $(X_1 + X_2)/2$

from either point. The energy of point X' will be determined by the combination of the various amplitudes of probability of charges based on which particle is occupying point X_1 and X_2 . Take in account that the amplitude of probability Ψ of \bar{X} will have two combinations: $|+-\rangle$ or $|-+\rangle$. We will take into consideration that the amplitude of probability Ψ will have two base states, C_1 and C_2 , where:

C_1 is the amplitude of probability that the proton will occupy point X_1 and the electron will occupy point X_2 .

C_2 is the amplitude of probability that the electron will occupy point X_1 and the proton will occupy point X_2 .

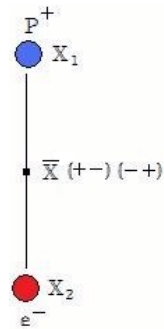


Fig. 1. Caption.

The overall amplitude of probability of having either combination can be determined as the sum of your base states:

$$\Psi = |+-\rangle + |-+\rangle = C_1 + C_2 \quad (2)$$

To determine the energy of point X' the Hamiltonian system of equations must be used.

$$\begin{cases} i\hbar \frac{dC_1}{dt} = C_1 H_{11} + C_2 H_{12} \\ i\hbar \frac{dC_2}{dt} = C_1 H_{21} + C_2 H_{22} \end{cases} \quad (3)$$

The solution of the system of differential equations is the function C_n :

$$C_n = a_n e^{-iEt/\hbar} \quad (4)$$

After replacing C_1 and C_2 with the function C_n the following system of equations is constructed and solved:

$$\begin{cases} i\hbar \frac{d}{dt} (a_1 e^{-iE_1 t/\hbar}) = a_1 e^{-iE_1 t/\hbar} H_{11} - a_2 e^{-iE_1 t/\hbar} H_{12} \\ i\hbar \frac{d}{dt} (a_2 e^{-iE_2 t/\hbar}) = -a_1 e^{-iE_2 t/\hbar} H_{21} + a_2 e^{-iE_2 t/\hbar} H_{22} \end{cases} \quad (5)$$

After factoring out $e^{-iEt/\hbar}$ from both sides of the equation and dividing by it we get a new set of equations:

$$\begin{cases} -a_1 E_1 = a_1 H_{11} - a_2 H_{12} \\ -a_2 E_2 = -a_1 H_{21} + a_2 H_{22} \end{cases} \quad (0)$$

The coefficient a_n will be described by the equation:

$$a_n = e^{-ikx_n} \quad (0)$$

After substituting a_n with the equation e^{-ikx_n} we get the system of equations:

$$\begin{cases} -E_1 e^{-ikx_1} = H_{11} e^{-ikx_1} - H_{12} e^{-ikx_2} \\ -E_2 e^{-ikx_2} = -H_{21} e^{-ikx_1} + H_{22} e^{-ikx_2} \end{cases} \quad (0)$$

Suppose $x_1 = -x_2$

$$\begin{cases} -E_1 e^{-ikx_1} = H_{11} e^{-ikx_1} - H_{12} e^{ikx_1} \\ -E_2 e^{ikx_1} = -H_{21} e^{-ikx_1} + H_{22} e^{ikx_1} \end{cases}$$

From the equations written above, we can solve for the value of energy E_1 and E_2 .

The value for the energy E_1 and E_2 will be determined by the following matrix:

$$\begin{vmatrix} H_{11} - E_0 & H_{12} \\ H_{21} & H_{22} - E_0 \end{vmatrix} = 0 \quad (0)$$

$$\begin{aligned} H_{11} &= E_0 + A \\ H_{22} &= E_0 - A \\ H_{12} &= H_{21} = A \end{aligned} \quad (0)$$

After taking the determinant of the substituted matrix:

$$\begin{vmatrix} E_0 + A & A \\ A & E_0 - A \end{vmatrix} = 0 \quad (0)$$

we get the value of energy for E_1 and E_2 .

$$\begin{aligned} E_1 &= E_0 + A = A\sqrt{2} + A = A(\sqrt{2} + 1) \\ E_2 &= E_0 - A = A\sqrt{2} - A = A(\sqrt{2} - 1) \end{aligned} \quad (0)$$

After solving our system of equations we can deduce that point X' will have two possible energy states; E_1 and E_2 . The amplitude of probability of having either energy state at X' can be described as the sum of the two individual amplitudes of E_1 and E_2 :

$$\Psi(E_1, E_2) = \Psi_1(E_1) + \Psi_2(E_2) \quad (0)$$

We presume that in a closed system of two charges, at point \bar{X} , two different levels of energy can occur.

$$\Psi(E_1, E_2) = a_1 e^{-iE_1 t/\hbar} + a_2 e^{-iE_2 t/\hbar}$$

We assume that in the above equation the coefficients a_1 and a_2 are equal to each other.

$$\Psi(E_1, E_2) = a \left[e^{-i(E_0 + A)t/\hbar} + e^{-i(E_0 - A)t/\hbar} \right] \quad (0)$$

$$\Psi(E_1, E_2) = 2a \cos \left[\frac{E_0 + A}{\hbar} t \right] \quad (0)$$

The amplitude of probability that point X' will have the energy E_1 or E_2 can be described using the harmonic function that is dependent on time. Knowing this, we can see that this process is constant and continuous in time. All these mathematical conclusions are necessary to understand how two opposite charges in space, can form in any point in space two different levels of energy E_1 or E_2 . Knowing this we can move toward our second discussion, which in my eyes is more interesting and more intriguing.

3. The Appearance of Elementary Exchange

Take in consideration a closed system with four charges, two positive and two negative. From the previous discussion, we assume that X'_1 and X'_2 will have two different levels of energy associated with each point.

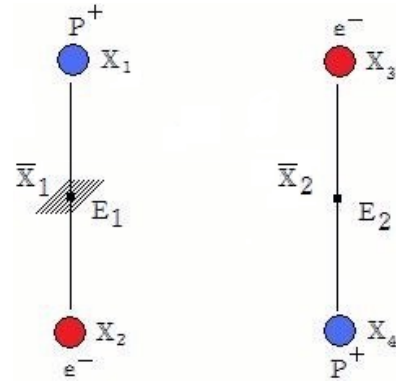


Fig. 3. Caption.

But in a closed system you cannot have two systems with equal levels of energy. This means that X'_1 has energy E_1 and X'_2 will have energy E_2 . Assuming that $E_1 > E_2$.

C_1 , which is the amplitude of probability that system 1 has energy E_1

C_2 , which is the amplitude of probability that system 2 has energy E_2

System 1 streams toward having a more energetically favorable condition, it does so by lowering its level of energy. By this reasoning, system 1 releases energy A that is received by system 2, which must in turn raise its energy level.

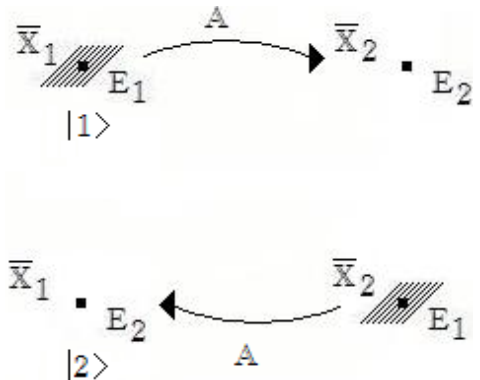


Fig. 4. Caption.

An amplitude of probability $|1\rangle$, exists that system 1 will release energy A and achieve the energy E_2 .

Similarly, an amplitude of probability $|2\rangle$, will occur where system 2 will accept energy A from system 1 and achieve energy level E_1 .

This process can go in the reverse direction. The overall amplitude of this process can be written as:

$$\Psi = |1\rangle + |2\rangle. \quad (0)$$

This interaction is very similar to other quantum interactions such as chemical, nuclear, and gravitational.

$$\begin{cases} ih \frac{dC_1}{dt} = C_1 H_{11} - C_2 H_{12} \\ ih \frac{dC_2}{dt} = C_1 H_{21} - C_2 H_{22} \end{cases} \quad (0)$$

Based on the previously discussed material and equations the overall amplitude of probability can be described using the following equation.

$$\Psi(E_1, E_2) = 2a \cos\left[\frac{E_0 A}{h} t\right] = 2a \cos[(\omega_0 + \omega_A) t] \quad (0)$$

The exchange of energy is constant in time. Now it becomes apparent as to why a force of attraction exists between two charges.

An interesting side note, two elementary charges, a proton and an electron, will not attract or repel each other at all. Elementary attraction can only occur in a system with four charges, two positive and two negative. Our old friend Coulomb was not correct. Time moves forward and we must as well.

4. The Appearance of Continuous Elementary Exchange

The system of equations shows that $|1\rangle$ will have energy E_1 , and $|2\rangle$ will have energy E_2 .

$$\begin{cases} ih \frac{dC_1}{dt} = C_1 H_{11} - C_2 H_{12} \\ ih \frac{dC_2}{dt} = C_1 H_{21} - C_2 H_{22} \end{cases}$$

where:

$$\begin{aligned} H_{12} &= -H_{21} \\ H_{21} &= -H_{22} \end{aligned}$$

To find a general solution for the system of equations, we will combine both equations together.

$$ih \frac{d}{dt}(C_1 + C_2) = (C_1 + C_2)(-H_{22} - H_{12}) \quad (0)$$

Now we will take the difference of the two equations.

$$ih \frac{d}{dt}(C_1 - C_2) = (C_1 - C_2)(H_{12} - H_{22}) \quad (0)$$

Continuing our mathematical analysis:

$$\begin{aligned} C_1 + C_2 &= ae^{-i(E_0 - A)t/h} \\ C_1 - C_2 &= be^{-i(E_0 + A)t/h} \end{aligned} \quad (0)$$

$$\begin{cases} C_1(t) = \frac{a}{2} e^{-i(E_0 - A)t/h} + \frac{b}{2} e^{-i(E_0 + A)t/h} \\ C_2(t) = \frac{a}{2} e^{-i(E_0 - A)t/h} - \frac{b}{2} e^{-i(E_0 + A)t/h} \end{cases} \quad (0)$$

$$\text{If } b = 0, \text{ then } \left. \begin{aligned} \omega &= \frac{E_0 - A}{h} \\ E_{\text{overall}} &= E_0 - A \end{aligned} \right| 1 \quad (0)$$

$$\text{If } a = 0, \text{ then } \left. \begin{aligned} \omega &= \frac{E_0 + A}{h} \\ E_{\text{overall}} &= E_0 + A \end{aligned} \right| 2 \quad (0)$$

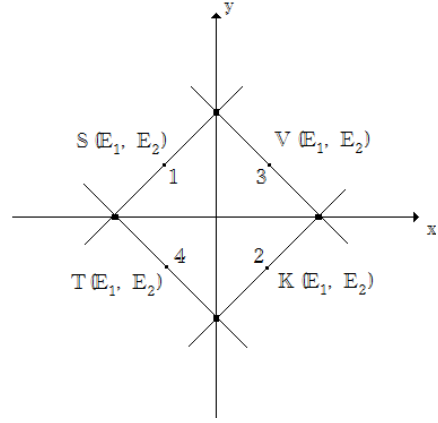


Fig. 5. Caption.

After doing some more mathematical operations we will get two final equations as solutions.

$$\begin{aligned} C_1(t) &= e^{-iE_0 t/h} \cos\left(\frac{At}{h}\right) \\ C_2(t) &= ie^{-iE_0 t/h} \sin\left(\frac{At}{h}\right) \end{aligned}$$

All these equations will show the continuous rising and dropping of energy at X'_1 and X'_2 .

The overall amplitude of probability of finding point X' in one of the possible energy states can be described by the equation:

$$C_1(t) + C_2(t) = e^{-iE_0 t/h} \left[\cos\left(\frac{At}{h}\right) + i \sin\left(\frac{At}{h}\right) \right] \quad (0)$$

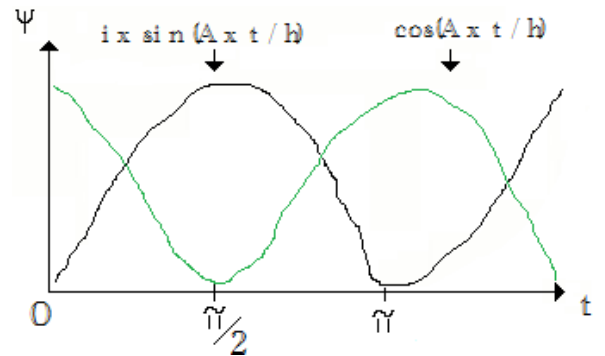


Fig. 6. Caption.

In a system with two dipoles there is a continuous exchange of elementary portions of energy.

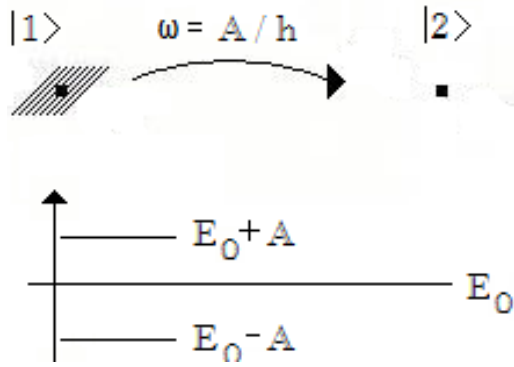


Fig. 7. Caption.

This occurs because the two points X'_1 and X'_2 have different levels of energy. The change over from one energy state to the other occurs by a transmission of an elementary portion of energy A which the other dipole accepts thereby raising its energy state. This continuous exchange of energy throughout time is what gives us a force of attraction between charges.

5. The Appearance of Elementary Charge Spin

Suppose in a closed system we have two dipoles. Dipole 1 will appear in point S which will have two different energy levels associated with it. Dipole 2 will appear in point K, also having two different energy levels. Pay attention to the fact that the negative charge in Dipole 1 will combine with the positive charge from Dipole 2 to create a new dipole, Dipole 3. Similarly the positive charge from Dipole 1 will come together with the negative charge of Dipole 2 to form Dipole 4. Dipole 3 will form in point V and will have two different energy levels associated with it while Dipole 4 will form in point T and will just as the others have two different energy levels associated with it. We will pick out a base state of C_1 that point S will have energy E_1 , base state C_2 will assume that point T will have energy E_2 . Base state C_3 will suppose that point K will have energy E_1 associated with it. Lastly, base state C_4 will assume that point V will have energy E_2 associated with it. $E_1 > E_2$.

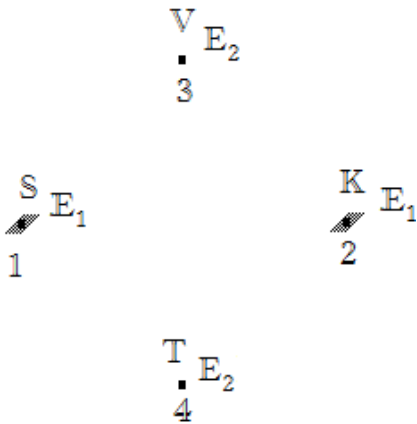


Fig. 8. Caption.

The amplitude of probability ψ_1 that point S will lower its energy level toward the direction of point V or point T will be:

$$\psi_1 = C_1C_2 + C_1C_4 \quad (0)$$

The amplitude of probability ψ_2 that point T will accept energy given off from point S or K and simultaneously raise its energy level will be:

$$\psi_2 = C_2C_1 + C_2C_3 \quad (0)$$

The amplitude of probability ψ_3 that point K will lower its energy level toward the direction of point V or point T will be:

$$\psi_3 = C_3C_2 + C_3C_4 \quad (0)$$

The amplitude of probability ψ_4 that point V will accept energy given off from point S or K and at the same time raise its energy level will be:

$$\psi_4 = C_4C_1 + C_4C_3 \quad (0)$$

From this, we construct a system of four equations:

$$\begin{cases} \psi_1 = C_1C_2 + C_1C_4 = a_1 e^{-iE_1 t/h} [C_2 + C_4] \\ \psi_2 = C_2C_1 + C_2C_3 = a_2 e^{-iE_2 t/h} [C_1 + C_3] \\ \psi_3 = C_3C_2 + C_3C_4 = a_3 e^{-iE_3 t/h} [C_2 + C_4] \\ \psi_4 = C_4C_1 + C_4C_3 = a_4 e^{-iE_4 t/h} [C_1 + C_3] \end{cases} \quad (0)$$

In this system, we assume that $E_1 = E_3$, while $E_2 = E_4$

6. Calculating the Energy Levels

$$i\hbar \frac{dC_{\text{overall}}}{dt} = \hat{H} \sum C_{\text{overall}} \quad (0)$$

$$i\hbar \frac{dC_1}{dt} = C_1E_0 - C_2A - C_4A$$

$$i\hbar \frac{dC_2}{dt} = C_2E_0 - C_1A - C_3A \quad (0)$$

$$i\hbar \frac{dC_3}{dt} = C_3E_0 - C_2A - C_4A$$

$$i\hbar \frac{dC_4}{dt} = C_4E_0 - C_1A - C_3A$$

From this system of equations which we put into a matrix, we get this determinant.

$$\det \begin{vmatrix} E_0 - E_1 & -A & 0 & -A \\ -A & E_0 - E_2 & -A & 0 \\ 0 & -A & E_0 - E_3 & -A \\ -A & 0 & -A & E_0 - E_4 \end{vmatrix} = 0 \quad (0)$$

After the solving for the determinant, we get two different levels of energy;

$$\begin{aligned} E_1, 3 &= E_0 + 2A \\ E_2, 4 &= E_0 - 2A \end{aligned} \quad (0)$$

After doing these calculations, we can obtain the equation for elementary charge spin.

$$= B \cos\left(\frac{2E_0}{h}t\right) - iB \sin\left(\frac{2E_0}{h}t\right) \quad (0)$$

where B , is a complex number that is dependent on R . R is the distance between points S, K, T, and V.

$$B = 5 + 2 \cos(2KR) + e^{-2iKR} \quad (0)$$

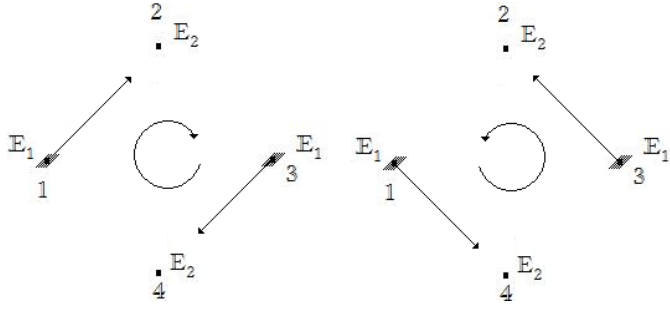


Fig. 8. Caption.

There are only 2 directions in which energy is released from points 1 and 3; clockwise or counter clockwise. The clockwise direction will create a spin of up, while the counter clockwise direction will create a down spin. The description of the exchange of energies between four charges has brought us to the problem of two states. Energy spin up, and energy spin down.

7. Exchange of Energy between Two Opposing Charge Spin Systems in a Cartesian Plane

In a closed Cartesian system, we have two opposing charge spin systems. The base state C_1 will assume that system 1 will have energy level E_1 , while base state C_2 will assume that system 2 will have energy level E_2 .

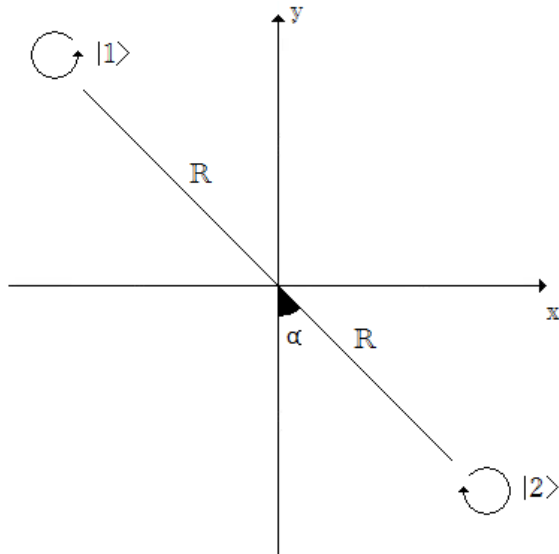


Fig. 9. Caption.

After our mathematical calculation we obtain the function for the amplitude of probabilities dependent on our radius vector R .

$$\begin{cases} (x) = 2e^{-i(E_0-A)t/\hbar} \cos[2kR(\cos)] \\ (y) = 2e^{-i(E_0-A)t/\hbar} \sin[2kR(\sin)] \end{cases} \quad (0)$$

If $\alpha = 0$, from our system of two equations we will just get one, where the amplitude of probability is solely dependent on x :

$$(x) = 2e^{-i(E_0-A)t/\hbar} \cos[2kR] \quad (0)$$

If $R = 0$,

$$(0) = 2e^{-i(E_0-A)t/\hbar} \quad (0)$$

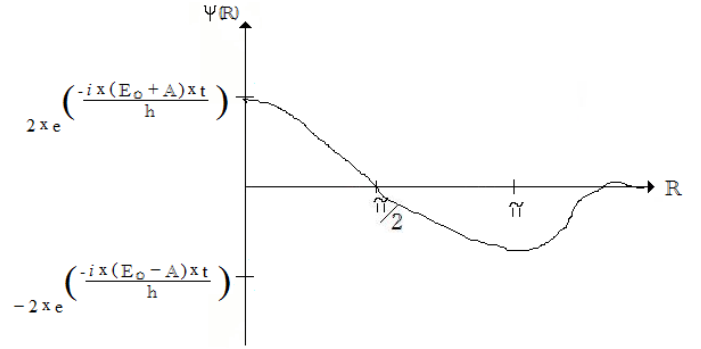


Fig. 10. Caption.

From this equation, we can determine in what coordinate x , the amplitude of probability for the exchange of energy drops to zero.

$$\frac{\pi}{4k} = 0 \quad (0)$$

This means at this particular point, the exchange of charge spin energy falls to zero.

The amplitude of probability decreases the amplitude of oscillations as a decreasing oscillating function. We obtain points, where the amplitude of probability for the exchange of energy will equal 0, and vice versa, we obtain points for an amplitude of probability where the exchange of energy will be maximum. This explains the distribution of electrons by their orbits/orbitals within the atomic structure. This distribution of charges reminds us greatly of gravitational interactions. However, in gravitational spin interaction differing energy levels give us elementary particle spin. (See previous paper, Physical Gravitational Interaction as a Two State Problem.)

In our present case, the interaction is caused by charge.

8. Emergence of Spin Levels: Equations

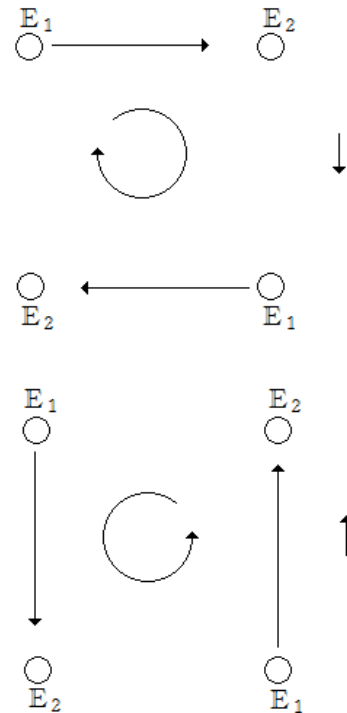


Fig. 11. Caption.

As was seen in the previous discussions, two dipoles come together to form four points in space with two different levels of energy, E_1 and E_2 . Differing direction for the exchange of energy, clockwise or counter clockwise, can be thought as spin and spin down, and the description of this mechanism again turns into a problem of two states.

Through the method of trial and error, we can derive the equation for determining differing levels of spin energy:

$$\Delta E = 4n^2 L |e| \quad ()$$

n = energy level

where

L = constant

e = charge magnitude

The figure shows four charges forming the first level spin energy. First level ($n = 1$) spin energy is described by the equation:

$$\Delta E_1 = 4L |e| \quad ()$$

Second level ($n = 2$) spin energy is described by the equation:

$$\Delta E_2 = 16L |e| \quad ()$$

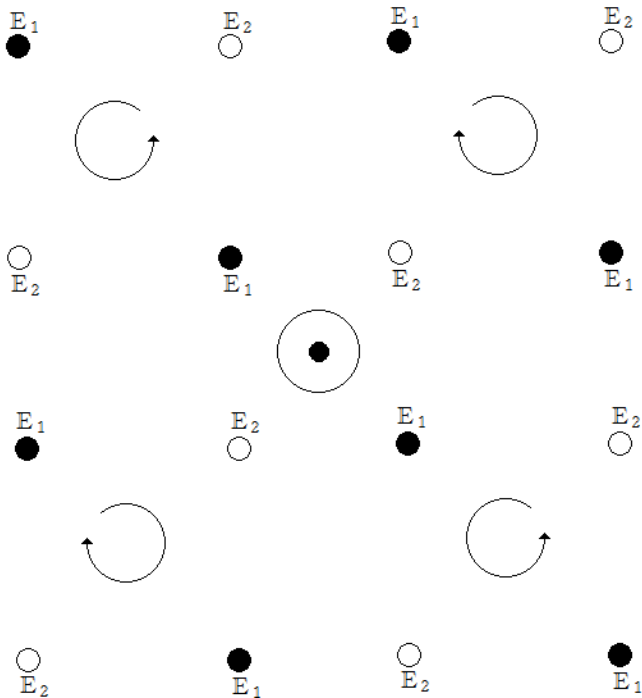


Fig. 12. Caption.

As seen in a system with eight dipoles, a spin emerges with a second energy level with a spin up and a spin down.

In the previous two examples we examined a spin system where $n=1$ and $n=2$, it can be deduced from our logic that more spin systems with $n=3$, $n=4$, and $n=N$ exist. All these problems involving differing levels of the spin energy all boil down to the problem of two states with a spin up and a spin down, the difference in the levels between the two systems is just a difference in the magnitude of energy.

9. The Problem with Monatomic Hydrogen

Let us now look at the atom of hydrogen. For some reason in nature only a molecule of diatomic

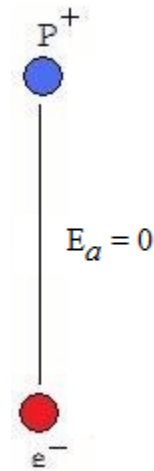


Fig. 13. Caption.

Hydrogen exists. A question should immediately emerge, why is there no atom of hydrogen? By logic stemming from classical coulomb's force, there must be an attraction between a positively charged proton and a negatively charged electron creating an ideal system which must exist in great numbers in nature. However you will be hard-pressed to find any at all anywhere. The question being is why? This is the first question which should emerge, the second being; since a Coulomb's force of attraction exists between a positively charged proton and a negatively charged electron, the electron must fall onto the proton. However that is never observed. Since monatomic hydrogen is never encountered in nature, it can be said that one electron behaves as if it never even sees one proton in such a system. Another question now emerges, is there any Coulomb's force of attraction between positive and negative charges. If there is some force of attraction, it cannot be Coulomb's force.

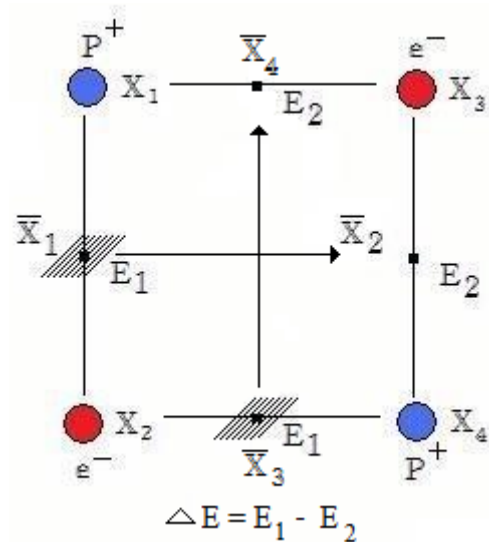


Fig. 14. Caption.

Let us now examine the explanation of physicists and chemists regarding Coulomb's force. "Inside an atom, the electron is pulled toward the nucleus due to Coulomb's force because the sign of their charges is different; however this attraction only works up to a certain distance because immediately forces of

atomic repulsion step in to push the electron off." This is too funny, is this for real? But ask yourselves this question, what is the force of atomic repulsion inside of an atom. Not one chemist or physicist will give you a concrete answer. The answer is simple; the force of atomic repulsion doesn't exist. This was thought up to save our precious Coulomb's Law. However we are in the business of physics, not preserving history. You may challenge me by saying that electrons due indeed push off from the nucleus, some force appears to be repelling them off. I cannot whole heartedly disagree because it does indeed appear that electrons are pushed off but simply try to explain these interactions without using Coulomb's law. You may ask yourselves how? The answer is quite simple.

Take your monatomic hydrogen, which cannot be found in nature, and call it simply a proton and an electron, an interaction cannot physically exist because your two particles are naturedly different. Interactions can only exist between like particles or like systems, or else they will not work. By this logic, your monatomic hydrogen does not exist.

Take one of our closed system in which you may find one dipole containing a proton and an electron, and now bring into this system a second dipole with an electron and a proton.

Dipole 1 will now create a level of energy E_1 at point X_1 , Dipole 2 will now create a different energy level E_2 at point X_2 , because X_1 and X_2 naturally cannot be the same and because our system is closed, an amplitude of probability will emerge that point X_1 will have energy E_1 and point X_2 will have a different energy E_2 , if $E_1 > E_2$. Then point X_1 will try to lower its energy level in the direction of X_2 , and X_2 will in turn raise its energy level. This will create an elementary exchange between points X_1 and X_2 . This is why you will never find monatomic hydrogen in nature, only molecular hydrogen exists.

Now pay attention to the fact that dipole 1 and dipole 2 create two more dipoles 3 and 4 see Figure 3F, which will also create differences in energy levels and which will also begin to exchange energy between them. The bonding energy between the two parts of a hydrogen molecule can be described using the equation:

$$\Delta EH_2 = \Delta E_1 + \Delta E_2 = (E_1 - E_2) + (E_1 - E_2) = 2(E_1 - E_2) \quad ()$$

where ΔEH_2 is the bonding energy for a molecule of hydrogen.

If you have been paying attention to this discussion, then you would have realized that a spin could have occurred. I could argue that in closed system a spin cannot form because there is no counter spin with which is exchange energy. There must be

two for spin to emerge, our system is closed. However if you put inside our system two more dipoles, then an amplitude of probability will occur that an exchange of energy will take place between our first group of dipoles and our second group. You may find yourself asking another question, why does bonding energy ΔEH_2 not simply take point X_1 and X_2 and crunch them together. The answer I have already given you in my previous equations, the answer lies in the fact that the amplitude of probability of an exchange of energy is dependent on the radius vector R between the points X_1 and X_2 as a harmonic function.

$$\Psi[R] \sim \cos[R] \quad ()$$

From this equation it can be seen that at different coordinates R the amplitude of probability for an exchange of energy to occur falls to zero, and vice versa there is a coordinate R where the amplitude of probability for an exchange of energy to occur is high. This is why if you try to bring the two dipoles closer together then they will return to their original coordinates because the amplitude of probability at those closer points falls to zero.

The energy of bonding is equal to the energy of repulsion at the exact same time. From this we can figure that the effective radius of a molecule of hydrogen

$$R_H = 2 \times 10^{-9} \text{ m} \quad ()$$

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