ABSTRACT

A magnetic interaction hypothesis (MIH) is suggested which leads to a re-interpretation of the interaction mechanism for the magnetic force. This MIH is used to explain energization of charged particles on micro scale. Further considerations including the nuclear force, inter-atomic stability, and the reproduction of spectral lines, are reported.

1:0 INTRODUCTION

Energization mechanism for charged particles has been a subject of much interest in the plasma physics [1]. The Sun emits these particles during various phenomena (such as, the solar flares, and the solar wind), [2,3] all of which interact with the geomagnetic field giving rise to several phenomena such as, the ring current, the Van Allan radiation belt, and the aurora in which the particles are highly accelerated, [4,5,6]. Many theories have tried to explain such accelerations. Among them are: acceleration by hydromagnetics shock waves, acceleration through atmospheric dynamo process, and the electric field acceleration [3]. But they have not been able to duplicate or explain the energization mechanism causing these phenomena [7]. Disclosing of this mechanism could help unlocking many of present unsolved mysteries, such as, the nuclear force formula [8], nuclear fusion mechanism [9], aurora mechanisms [10] and several other phenomena [11]. It is known that the forces keeping electrons around nucleus, are both the electrostatic and the electromagnetism [12], but no mechanism had been suggested for it. This paper however tries to tackle these problems by (I) re-interpreting the nature and mechanism of the magnetic force, and (ii) suggesting a magnetic interaction hypothesis (MIH), through which any generalised magnetic field interacts with a circular magnetic field (CMF) and (iii) re-defining the spinning magnetic field (SMF) interaction in terms of the nuclear force that binds the nucleons. Using both the CMF and SMF the atom formation, inter-atomic energization processes and the reproduction of the spectral lines are considered. MIH was published in 2003 [13], the present modification re-address among others, the inter-atomic forces.

2:0 THE MAGNETIC FORCE

2:1 THE CIRCULAR MAGNETIC FIELD (CMF)

Through experience [14], the attractive and repulsive forces between two conductors $C_1$ and $C_2$ carrying electric currents $I_1$ and $I_2$ separated by distance d metre, adopted for the definition of electric current [14], is given electrically by
But since the above conductors \((C_1\) and \(C_2\)) carrying electric currents \((I_1\) and \(I_2\)) therefore, the circular magnetic field \((CMF)\) produced by each at a distance \(r_C\) from the conductor is given by

\[
B_{C1} = B_{C2} = \frac{2kI_{1(2)}}{r} \text{T} \tag{2}
\]

Where, \(k=2x10^{-7}\) Newton per square ampere \([12]\).

As supposed by Faraday \([15]\) magnetic lines of force tends to shorten in length or repelling one another sideways, such that the force obtained by Eq.(1) could be conceived as due to both conductor’s CMF shorten or repelling each other, as shown in Fig.1 and Fig.2, such that the repulsive and attractive force is given magnetically by

\[
F_m = \frac{B_{c1}B_{c2}r_1r_2l_1}{2k} \text{N} \tag{3}
\]

Where, both \(B_{c1}\) and \(B_{c2}\) are CMF (in Tesla) produced by conductors \(C_1\) and \(C_2\) respectively, while \(r_1\) and \(r_2\) are the CMF’s radii in metre, \(l_1\) is the length of the conductor in metre.

![Diagram](attachment:diagram.png)

**Fig.1.** Production of circular magnetic field \((CMF)\) \([12]\), the figure also shows the direction of CMF, the interaction line and direction of the produced force.

The Catapult force or the motor effect \([12]\) is given by:

\[
F_{e.m.} = B_1l_1l_2 \text{ N} \tag{4}
\]

Where, \(B_1\) is the magnetic field, \(l_2\) is the length of the conductor cutting the field in metre; \(I_1\)
is the current in the conductor in Ampere and the magnetic force $F_{e.m}$, given by electromagnetic parameters is in Newton.

Fig. 2. Cross-section views of conductors carrying electric current. Produced circular magnetic field (CMF) [12] interacted magnetically producing the magnetic force. Direction of both CMF’s determined the direction of the force [12], in (a) it is attractive, while repulsive in (b).

The repulsive and attractive nature of magnetic lines of force causing Catapult force above, is express magnetically by

$$F_m = \frac{B_1 B_{c2} l_3 r_2}{2k} N \quad (5)$$

Where, $B_1$ is a general magnetic field, $B_{c2}$ is the CMF produced by the conductor, $r_2$ is the radius of the CMF, $l_1$ is the length of the conductor producing the CMF that interact with $B_1$, the magnetic force $F_m$ is in Newton. Table.1. Shows the parameters relating magnetic force given by Eqs.(1), {3}, (4) and {5}.

<table>
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<th>$l_1$ m</th>
<th>$D$ M</th>
<th>$R$ M</th>
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Table.1. Samples of parameters that gives an equivalent magnetic force in Eqs.(1), {3}, (4) and {5}, when used in its proper equation.
From both Maxwell's and Einstein's theories about magnetic field produced by charge in motion [16], it can be deduced that the magnitude of the CMF (or $B_{2e}$ and $B_{2p}$ for electron and proton respectively) produced by a charged particle in motion [17, 18, 19] is given by

$$B_2 = \frac{q \cdot v}{r_m^2 \cdot c} \cdot N \quad (6)$$

Where, $c$ is the speed of light, $q$ is the particle's charge in coulombs, $v$ is the charged particles velocity in ms$^{-1}$, $r_m$ is the magnetic radius at which the CMF is measured (representing $r_{me}$ and $r_{mp}$ or electron's and proton's magnetic radius respectively). The circular magnetic field $B_2$ is given in Tesla.

**Fig. 3. ECMF and PCMF [16,17,18] ($B_{2e}$ and $B_{2p}$ respectively) of equal energies interacted with magnetic field ($B_I$), at specific points. Resulted magnetic force ($F_m$) caused electron and proton to gyrate oppositely at specific radius.**

$$F_m = B_1 \cdot B_2 \cdot r_m \cdot C \cdot \sin \theta = q \cdot v \cdot B_1 \cdot \sin \theta \cdot N \quad (7)$$

The Lorentz force ascribed to the existence of electrostatic field, used in explaining the characteristics of the magnetic force [20], while the magnetic force as associated with moving source charges is related to interaction of current bearing wire [21] shown by Eq.(1), the force is given by

Where, $\theta$ is the angle between the trajectory and the fields. This force, is given with electric-magnetic parameters can be conceived to be caused by the magnetic interaction, where, as shown in Fig.3 the CMF ($B_2$) given by Eq.(6) interact magnetically with the general magnetic field $B_I$ such that
\[ F_m = B_1 B_2 r_m^2 c \sin \theta \quad N \quad \{8\} \]

Where, \( \theta \) is the angle between the two fields. While Fig.3 shows the magnetic interaction patterns between both the electron’s CMF and the proton’s CMF with the general magnetic field \( B_1 \), Fig.4, shows variation of \( F_m \) with \( r_m \).

**2.2 THE SPINNING MAGNETIC FIELD (SMF) and NUCLEAR FORCE**

**2.2.1 THE SPINNING MAGNETIC FIELD**

The magnetic field produced above the poles of the spinning nucleon [22] is due to total magnetic field (\( B_T \)), and is here identified as the spinning magnetic field (SMF). For proton, the magnitude of the total magnetic field (\( B_{TP} \)) produced above each pole as shown in Fig.5.a, is derived from Newton’s second law, Coulomb’s electrostatic law and Biot-Savart law for magnetic field outside a loop [14], given by:

\[
B_{TP} = B_{1P} r_r^2 = \frac{\mu_0}{4 \pi} \frac{q^2 r_0}{\varepsilon_0 f_{PS} m_P r_p^2} = 1.525710414 \times 10^{-18} \ T \cdot m^2 \quad \{9\}
\]

Where, \( B_{1P} \) is proton’s SMF (\( B_{1U} \) for nucleus hydrogen atom), \( f_{PS} \) is the proton’s spinning frequency, \( r_0 \) is the radial distance from proton surface to a point at which \( B_{TP} \) is produced (\( r_0 = 0.468 \) fm), \( r_r \) is distance from proton’s surface along the magnetic field, \( \mu_0 \) is the permeability of the free space, \( \varepsilon_0 \) is the permittivity of free space.
Fig. 5. The proton’s dipole spinning, magnetic field (PSMF) production [21], above the surface in (a) it also shows two PSMF interacted magnetically. In (b) attractive produced magnetic force increased exponentially till $r = 0.936\text{fm}$ ($r_r = 0.468\text{fm}$) ($\text{fm} = 10^{-15} \text{m}$), then the force decreased, where it becomes repulsive, due to PSMF characteristics, using Eqs. {12}, all of which showing nuclear force ($F_n$)
characteristics.

2:2:2 THE SPINNING MAGNETIC FORCE or (SMFc) THE NUCLEAR FORCE
When opposite proton's spinning magnetic field (PSMF) comes under the field influence of each other as shown in Fig.5:a, an attractive spinning magnetic force (SMFCA) or (FNA) is established as in Fig.5:b, and derived from Eq.[8], this force is given by:

\[ F_{NA} = \left( \frac{B_{TP}^2}{r_T^2} \right) c \ N \quad (10) \]

Which we here interpret as the nuclear force, In according to characteristics given [8]. The SMFc or nuclear force FN varies as shown in Fig.5:b, whereby at relatively large distances the attraction of both SMF dominates up to \( r = 0.468 \text{fm} (r = 0.936 \text{fm}, (\text{fm} = 10^{-15}) \) as given by Eq.{10}. Thereafter, for \( r < 0.468 \text{ fm}, \) magnitude of the SMF starts to decrease and so does FNA given by the right hand part of Eq.{11}. For smaller values than \( r = 0.468 \text{ fm}, \) the preceding parts of the poles with similar SMFs interact with each other thus producing an FNR opposing the two protons from fusing together, given by the left part of Eq.{11}. This repulsive force (FNR) is the resultant of both two forces, as shown in Fig.5b, given by:

\[ F_{RN} = \left( \frac{B_{TP}^2}{r_T^2} \right) c = \left( \frac{B_{TP}^2}{(r_o + r_p) + r_o^2} \right) c \ N \quad (11) \]

Where, \( n \) is the number of steps moved by SMF starting from \( r = 0.8 \text{ fm} (r = 0.4 \text{fm}), r_x \) is the distance moved at each step \( (r = 0.05 \text{fm}), \) the characteristics are shown in Fig.5.

Combining Eqs.{10} and {11}, the spinning magnetic force \( (F_S) \) or the nuclear force \( (F_N) \) is given by:

\[ F_N = \left( \frac{n^2}{(r_o + r_p) - (nr_x)} \right) c = \left( \frac{B_{TP}^2}{r_T^2} \right) c + \left( \frac{B_{TP}^2}{(r_o + r_p) + r_o^2} \right) c \ N \quad (12) \]

3:0 ENERGIZATION OF CHARGED PARTICLES
Assuming a system (such as that of Fig.3) if the magnetic field which is denoted by \( B_1 \) is in three dimensions rotation or motion, when an electron's or proton's CMF (B2e and B2p respectively) interacts with the \( B_1, \) then the resulting magnetic force between both fields also joins the charged particles such that they all move with the magnetic field \( (B_1) \). Thus if the magnetic force travels a distance \( d_K \) (\( d_K = d_y + d_z \)) in unit time, then the work done is given by \[ W = B_1 B_2 r_m^2 c \ d_K \ sin \theta \quad (13) \]

Which is equal to the total (kinetic and potential) change in energy of the body acted on by the force [24] since the displacement and the magnetic force are in the same sense and direction, therefore from Eq.{13} the kinetic energy \( K \) of the charged particles is given by:

\[ K = B_1 B_2 r_m^2 c \ d_K \ sin \theta \quad (14) \]
Where, $B_1$ is the rotating magnetic field, $B_2$ is the CMF, $r_m$ is the radius of gyration, $\theta$ is the angle between the two fields at interaction moment.

Fig.6, shows the relationship between different solar wind electrons velocities verses values at which it has been energized at microscopic level, at the magnetopause boundaries, where $\theta = 90^\circ$.

![Graph of First level energization process verses electrons velocity, due to data shown in Fig.4.](image)

### 4.0 MAGNETIC INTERACTION AND ATOMIC MODEL

#### 4.1 INTER-ATOMIC FORCES AND STABILITY

Based on this hypothesis, whenever an electron comes under the influence of a nucleus electric field at an electrostatic distance $r_e$ the electron is accelerated by the electrostatic force such that its velocity $v_e$ and CMF increases. Thus at a specific radius regulated by $\mu_e$ in Eq.(26), the electron’s CMF will interact magnetically with the nucleus spin magnetic field (NSMF) forming an atom, or increasing the nucleus constituent. NSMF in its simplest form comprising the proton spinning magnetic field PSMF to form a hydrogen atom when interacted with electron's CMF.

At specific electrostatic atomic radius $r_{ee}$ the electrostatic force $F_e$ is balanced with the produced magnetic force $F_m$, and both forces are balanced with the centripetal force ($F_C$), leading to the stability of the atom as shown in Fig.7, for hydrogen atom and given generally by Eq.(15) bellow, while the degree of this stability is determined by $\mu_e$ in Eq.(26). The balance of forces is such that

$$2F_c = (F_e + F_m) = \left\{ 2\left(\frac{m_ev_o^2}{r_{me}}\right) \right\} = \left\{ (B_{1u}B_{2e}r_{me} c) + \left(\frac{Z e Q}{4\pi\varepsilon_0v_o^2}\right) \right\} N \quad \{15\}$$

Where, $B_{1u}$ is the nucleus SMF, $B_{2e}$ is orbital electron’ CMF, $m_e$ is electron's mass, $r_{ee}$ is the electron's electrostatic atomic radius, $r_{me}$ is the electron's magnetic radius, $v_o$ is electron's
natural orbital velocity around the nucleus, $\varepsilon_0$ is the permittivity of the free space.

\[ F_c = m_e v_o / r_{me} = ZeQ/4 \pi \varepsilon r_{ee} + B_{1u} B_{2e} r_{me} c = ZeQ/4 \pi \varepsilon r_{ee} + qv_o B_{1u} \ N \]

Fig. 7. Stable hydrogen atom, where Electron CMF ($B_{2e}$) interacted with Proton SMF ($B_{1p}$), then at specific magnetic radius ($r_{me}$) and electrostatic radius ($r_{ee}$), both magnetic force ($F_m$) and electrostatic force ($F_e$) are balanced with the centripetal force ($F_C$).

Since Eq. (8) represents Eq. (7), therefore the above equation becomes

\[ \{2F_e = (F_e + F_m) = \left\{2 \left( m_e v_o^2 / r_{me} \right) \right\} = \{(q v_o B_{1u}) + \left( Z e Q / 4\pi \varepsilon_0 r_{ee}^2 \right) \} \ N \quad \{16\} \]

From Eq. (16), the following is derived:

\[ F_c = F_e = F_m = \left( m_e v_o^2 / r_{me} \right) = (q v_o B_{1u}) = \left( Z e Q / 4\pi \varepsilon_0 r_{ee}^2 \right) \ N \quad \{17\} \]

From the balance of electrostatic and magnetic forces given by Eq. (17) above, the electrostatic orbital atomic radius $r_{ee}$ at which an electron stabilised is given by

\[ r_{ee} = \sqrt[3]{q / 4\pi \varepsilon_0 B_{1u} v_o} \ m \quad \{18\} \]

Relating Eq. (17) with angular momentum introduced by Bohr, in his atomic hypothesis [25],
the electrostatic orbital radius $r_{ee}$ is also given by

$$r_{ee} = \frac{\varepsilon_0 \ h^3}{4 \pi^2 m_e^2 \mu_e q} \ m \quad \{19\}$$

While the orbital velocity $v_o$ could be derived from Eq.\{3\}, or from Bohr atomic hypothesis [25]

$$v_o = \frac{\hbar}{2 \pi \ m_e \ r_{ee}} \ m \ s^{-1} \quad \{20\}$$

Where, $\hbar$ is Planck’s constant.

### 4:2 Electrons’ Parameters at Orbital Radius

We assumed that the stability of an atom at certain orbital radius is due to the balance of both $F_e$ and $F_m$ with $F_C$, as shown in Fig.7, with parameters given in Table.2. Hence the electrostatic atomic radius $r_{ee}$ (all of the following parameters are derived from Eq.\{17\}, as given in Table.2.) at orbital level take the form

$$r_{ee} = \sqrt{\left( B_{TP} \right) + \left( \frac{q}{4\pi \varepsilon_0 \ v_o} \right) \left( \frac{q^3}{4\pi \varepsilon_0 \ m_e^2 \ v_o^3} \right)} \ m \quad \{21\}$$

While the magnetic radius $r_{me}$ (equal to Bohr radius $r_B$) takes the form

$$r_{me} = \frac{4\pi \varepsilon_0 \ m_e \ v_o^2 \ r_{ee}^2}{q^2} = \frac{2 \mu_e}{q \ v_o} = r_B = \frac{\varepsilon_0 \ h^2}{\pi \ m_e q^2} \ m \quad \{22\}$$

Where, $r_B$ is Bohr radius, and the SMF radius $r_r$ is given by:

$$r_r = \sqrt{\frac{4\pi \varepsilon_0 \ v_o \ r_{ee}^2 \ B_{TP}}{q}} \ m \quad \{23\}$$

And the NSMF ($B_{1U}$) or $B_{1p}$ for hydrogen atom is given by:

$$B_{1U} = \frac{q}{4\pi \varepsilon_0 \ v_o \ r_{ee}^2} \ T \quad \{24\}$$

For hydrogen atom, parameters obtained due to the balance of both $F_e$ and $F_m$ with $F_C$ is given in Table.2. From Eq.\{22\}, the electrostatic atomic radius also could be given by

$$r_{ee} = \frac{\hbar}{4 \pi v_o \ m_e} \ m \quad \{25\}$$

### 4:3 The Magnetic Moment

The flipping effect (i.e. the magnetic moment) produced in magnetic resonance experiments [9] are seen as, the response of an energetic charged particle’s CMF to any specific magnetic
field. For an electron in an atom, this magnetic moment \( \mu_e = E_0/B_1U \) is obtained by substituting electron's orbital energy and nucleus SMF given by Eq.(24) in the following sequence

\[
\mu_e = \frac{m_e v_o^2}{2B_{1U}} = \frac{2\pi \varepsilon_o v_o^3 m_e r_e^2}{q} = \mu_B = \frac{q v_o r_{me}}{2} \quad J.T^{-1} \quad \{26\}
\]

Where, \( B_{1U} \) is nucleus spinning magnetic field (NSMF), \( \mu_B \) is Bohr magneton, \( \mu_e \) is atomic electron magnetic moment related to atom stability.

Eq.(26) can be used to determine the stability orbit for both the electron's CMF and NSMF as shown in Fig.7, and numerically as in Table.2, for atomic hydrogen.

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Table.2. Electron's parameters at natural orbit in for hydrogen atom. This Table should be read in connection with Fig.7, and Eqs.(16, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 31).

5:0 INTER-ATOMIC ENERGIZATION and the REPRODUCTION of SPECTRAL LINE

From the magnetic interaction hypothesis based on Eqs.(8), (13) and (14), any electron gyrating at its natural orbit in an atom under the influence of the spinning magnetic force, continually undergoes an energization process so that it acquires an amount of orbital energy

\[
E_o = \frac{r_{me} q v_o B_{1U}}{2} \quad J \quad \{27\}
\]

With reference to Fig.8, whenever such an electron is subjected to an excitation potential, both its kinetic energy and the CMF \( (B_{2e}) \) increases and hence the magnetic force increases as well. This force increases the orbital radius so that the radial energy change is obtained as

\[
E_n = \frac{r_n q v_p B_{1U}}{2} \quad J \quad \{28\}
\]

Where, \( v_p \) is the excitation velocity, \( r_n \) is the excited orbital radius. The quanta of energy acquired by the electron at that radius will be radiated as an electromagnetic radiation, the sequence of which is shown in Table.3, with the wavelength given by
\[ \lambda = \frac{2 \ h \ c}{r_n \ q \ v_D B_{1u}} \ \text{Å} \ \ \ {29} \]

From Eqs.\{18\} and \{27\}, the general excitation energy at any radial distance within the atomic excitation range becomes

\[ E_n = \frac{m_e \ v_n \ v_D}{2} \ j \ \ \ \ {30} \]

Where, \( v_n = v_D + v_o \), i.e. the excited radial velocity.

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<th>( B_{2n} ) T</th>
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<th>( r_n ) ( x10^{-11} ) m</th>
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Table.3. Samples of sequences through which an excited electron in hydrogen atom transverse, before radiating specific wavelength using Eq.\{28\}, as shown in Fig.8.

Thus the radiated wavelength \( \lambda \) due to such a specific energy quantum (an example of which is shown in Table.4, to be compared with Table.3.) is given by

\[ \lambda = \frac{2 \ h \ c}{m_e \ v_n \ v_D} \ \text{Å} \ \ \ {31} \]

Hence,

\[ v_o = \frac{2 \ h \ c}{m_e \ v_D \ \text{Å}} - v_D \ m.s^{-1} \ \ \ {32} \]

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Table.4 Reproduction of spectral lines by excited electrons, using Eq.\{31\} and Eq.\{32\}, reducing steps used in Table.3.
Fig.8. Spectral line sequential reproduction for hydrogen atom. Each quanta of series energy is due to multiplication of both the magnetic level accelerating force \( (F_n) \) by the spinning distance \( (ds) \). After radiating the quanta of energy, electron is accelerated back to the natural orbit by Fee.

**6.0 DISCUSSIONS**

1- Although magnetic fields are produced due to relative motion of charged particles, the direct cause of the magnetic force is here considered to result from the interaction of magnetic fields. This interaction explains the mechanism behind the attractive and the repulsive forces between any two wires carrying electric currents as shown in Fig.2. It also explains the orbital excitation energy characteristics for charged particles and why the direction gyration of an electron is opposite to that of a proton, as shown in Fig.3.

2- The exponential nature of Fig.5 is due to the production of spinning magnetic fields, and above proton's surface \( (r = 0.468\text{fm}) \) as proved for neutron’s SMF \[26\], compared with Fig.4.

3- The exact measured magnitude of the nuclear force for the proton is determined by the magnitude of produced \( B_{Tp} \) given by Eq. \[9\]. In this case it is related to the magnetic moment value. Since the value of the proton's angular frequency \( (\omega_p) \) has been determined as 0.5 rad. sec. (i.e. from Eqs. \[26\], \[27\], \[28\], \[29\], \[30\], and \[31\]), therefore its spinning frequency \( (f_{ps}) \) is of the magnitude of \( 0.079577471 \text{ s}^{-1} \), from which \( B_{Tp} \) is derived.

4- The CMF interaction with the magnetic field \( (B_1) \) is represented in Fig.3. The same
mechanism occurred inside an atom where the balance of both the $F_e$ and $F_m$ with $F_C$ at specific $r_{ee}$ and $r_{me}$ brings stability to the atom, as shown in Fig. 7.

5- The nature of the magnetic interaction is that, the weaker CMF ($B_2$) interacts with the stronger magnetic field ($B_1$) at two specific points. These two points arise due to the variation in the strength of $B_{ip}$ as shown in Fig.7, for hydrogen atom.

6- From Eqs.\{18\}, \{20\} and \{24\}, the value of $r_{ee}$ include proton's radius $r_p$, and electron's radius $r_e$. Both are thought to be equal, and derived from Eq.\{9\}.

7- The Bohr radius ($r_B$), giving in the right hand side of Eq.\{22\}, is resulted from the balance of both the Coulomb's electrostatic and centripetal forces, (with value of $0.5291793603 \times 10^{-10}$ m) [27, 28], it gives the same value given by the magnetic radius ($r_{me}$), therefore both are equal and given by Eq.\{22\} and shown in Table.2.

8- The known value for electron's orbital angular momentum ($L_o$) [29] is $1.054x10^{-34}$ kg.m$^2$s$^{-1}$. While the value obtained from Table.2, parameters are $1.054572669x10^{-34}$ kg.m$^2$s$^{-1}$ using $r_{ee}$.

9- Electron's magnetic moment $\mu_e = 9.284770119x10^{-24}$ j/T obtained from multiplication of Bohr magneton ($\mu_B$) [30] by $1.001159652193$ as verified by experiments [22, 31], is obtained with the same value using any of Eq.\{26\}, thus Bohr magneton ($\mu_B$) gives correct magnetic moment value when using correct parameters ($\nu_0$ and $r_{me}$).

10- The electrostatic radius, $r_{ee}$ which determined $\nu_0$, $F_e$, $r_{me}$, $r_e$, and $B_{1U}$ is derived by Eq.\{19\} using $\mu_e$ and $h$, or Eq.\{21\}, or Eq.\{25\}, all of which give the value of $0.528566407x10^{-10}$m, and given in Table.2.

11- The $\nu_0$ is derived either from Planck's relation Eq.\{20\} or the radiated spectral line, given by Eq.\{32\}.

12- The known proton's radius ($r_p$) [22], is $1x10^{-15}$ m, while from Eq.\{9\}, $r_p=1.1060236231x10^{-15}$ m.

13- The excitation energy ($E_D$) is relative to the ionisation energy [27, 28], for hydrogen atom the ionisation energy, used in Eqs. {27}.\{28\}.\{29\} \{30\} and\{31\} is $13.5981$ eV [26].

14- For any atom if both the radiated wavelength $\lambda$ and the excitation velocity $\nu_D$ is known then the electron's natural orbital velocity $\nu_0$ (at natural orbital radius) can be obtained using Eqs.\{20\} or \{32\}.

15- With reference to two points above, atomic spectral lines can be reproduced as shown in Fig.8. While Table.3, shows the reproduction sequential mechanism, and Table.4, summarised all of Table.3, using only Eq.\{31\}, both tables gives the same results.

16- Energy changes for charged particles therefore take the following two forms:

(a) The normal work done due to the displacement of the magnetic force from the normal orbital radius ($r_{me}$) to the excitation orbital radius ($r_n$) inside an atom, the energy of which is radiated, as shown in Fig.8.

(b) Starting from the single particle micro-level, energy as given by Eq.\{14\} and shown in Fig.6, electrons and protons can proceed to higher radial energy, due to the produced external magnetic field ($ExMF$). The several steps of energization may lead to acceleration mechanisms, such as those found in the magnetopause boundary in the transition region [3, 32], both aurora oval [6], and stable aurora red arc system (SAR-arc) [33], radiation belts [3], and the ring current's [6] comprising charged particles.

17- From Fig.5:b. The degree of stability for two nucleons depends on the equilibrium distance, where attraction and repulsion forces are balanced, similar to forces between two atoms [34]. Relative unbalance of the nuclear force magnitude causes the vibration (or oscillation) motion of both nucleons (around 0.7 Fm, as shown in Fig.5.b.b.). Similar to the molecule's vibration motion of the spring form, associated with energy [35, 36]. Larger
nucleus $B_{TV}$ magnitudes, give higher oscillations and lower nucleus nuclear stability, with the associated energy and consequently leading to decay processes.

18- From point (15), the smallest excitation potential of $1.982807168\times10^{-3}$ eV can reproduce Pfund series of 74599.21569Å in hydrogen atom. This therefore reveals the precision of all natural phenomena mechanisms.

19- The 1922, silver atoms beam experiment carried out by Otto Stern and Walther Gerlach, where the beam split into two sub-beams on the detecting plate by the action of the electromagnetic field [29].

The experiment is re-interpreted as:

(a) While in motion, the silver atom NSMF foreheads consist of both NSMF.

(b) In uniform field, each forward NSMF detected the field as relatively equal magnitude of $B$.

Thus $F = (B_1) (B_{2N}) r^2 c$, gives net $F = 0$.

(c) In no uniform field, each of the NSMF interacted as follow:

-NSMF is attracted upward by $-F = (+B_1) (-B_{2U}) r^2 c$.

+NSMF is repelled downward by $+F = (+B_1) (+B_{2U}) r^2 c$.

Therefore the silver atoms formed split on the detected glass.

20- The measured nuclear force between two protons which is $(45)^2$ times greater than the electric force [8], is re-interpreted as kinetic energy phase of great accelerated nucleons.

21- The MIHI open the door for several new ideas in many fields.

22- Physical constant used, are:

$q = 1.60217733x10^{-19}$ C.

$m_e = 9.1093897x10^{-31}$ kg.

$m_p = 1.6726231x10^{-27}$ kg.

$h = 6.6260755x10^{-34}$ J.s [12].

$\varepsilon_0 = 8.854223x10^{-12}$ C$^2$.N$^{-1}$.m$^{-2}$ [37].

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7:0 Glossaries

$B_1$: Magnetic field

$B_{TV}$: Nucleus spinning magnetic field (NSMF)

$B_2$: The CMF

$B_{2e}$: Electron's CMF.

$B_{2e}$: Orbital electron’s CMF

$B_{2p}$: Proton's CMF.
**B_T**: Total Magnetic Field.

**B_{Tp}**: Proton's total magnetic field.

**CMF**: Circular magnetic field.

$$d_K (d_x = d_y + d_z)$$: Energization distance travels by magnetic force.

**ExMF**: External Magnetic Field.

**F_C**: Centripetal force.

**F_e**: Electrostatic force.

**F_m**: Magnetic force.

**f_{ps}**: Proton's Spinning frequency.

**h**: Planck's constant.

**K**: Kinetic energy of charged particles.

**L_o**: Electron's orbital angular momentum.

**m_e**: Electron's mass.

**MIH**: Magnetic Interaction Hypothesis.

**NSMF**: Nucleus spinning magnetic field.

**PSMF**: Proton's Spinning Magnetic Field.

**r_B**: Bohr radius.

**r_{ee}**: Electron's electrostatic atomic radius.

**r_m**: Magnetic radius of gyration.

**r_{me}**: Electron's magnetic radius (equivalent of Bohr radius).

**r_n**: Excitation orbital radius.

**r_r**: SMF radius.

**SMF**: Spinning magnetic field.

**SMF_{CA}**: Attractive spinning magnetic force.

**v_c**: Charged particles velocity.

**v_o**: Electron's natural orbital velocity around the nucleus.

$$v_n = v_o + v_\theta$$: The excited radial velocity.

**\varepsilon_0**: Permittivity of the free space.

**\theta**: Angle between two fields at interaction moment.

**\lambda**: Wavelength.

**\mu_B**: Bohr magneton.

**\mu_e**: Atomic electron magnetic moment related to atom stability.

**\omega_p**: Proton's angular frequency.

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8:0 **REFERENCE**


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