the general science journal

On the Magnetostatic Inverse Cube Law and magnetic monopoles

André Michaud
srp2@globetrotter.net
Service de Recherche Pédagogique
http://pages.globetrotter.net/srp/

Quoted from
Expanded Maxwellian Geometry of Space, 4th edition
http://pages.globetrotter.net/srp/geomax2a.htm

Abstract :

1) It can be experimentally demonstrated that interaction between magnetostatic fields for which both poles geometrically coincide obeys the inverse cube law of attraction and repulsion with distance which proves by similarity that localized (in the sense of behaving as if they were point-like) electromagnetic elementary particles must obey the same interaction law since both of their own magnetic poles have to coincide with each other by structure, given their point-like behaviour.

2) As a corollary, and contrary to electric dipoles whose two aspects (opposite sign charges) can be separated in space and observed separately, it can also be demonstrated that both aspects of magnetic dipoles whose poles coincide can be separated only in time, which characteristic highlights the fact that point-like elementary electromagnetic particles can magnetically interact only as if they were physical magnetic monopoles at any given moment.

3) The related cyclic polarity reversal of the magnetic aspect of elementary electromagnetic particles such as electrons, quarks up and quarks down and of their carrying energy brings a new and very interesting explanation to the reason why electrons do not crash on their own onto nuclei despite electrostatic attraction by showing that magnetic interaction between nuclei and electronic escort can only be repulsive.

We will examine here a very simple experiment that demonstrates that the magnetostatic inverse cube interaction law is by no means a postulate, but a real physically existing law, which is at play between magnetostatic fields for which both poles geometrically coincide, instead of the inverse square law which is so often assumed in the community, and even wrongly associated with magnetostatic interaction.

Strangely, although we have had at our disposal for hundreds of years easy to reproduce experiments allowing experimentally verifying of the inverse square law of distance for electrostatic interaction for point-like charges, that is Coulomb's law, I found no trace on record of such an experiment that would allow experimentally verifying the inverse cube law of distance for magnetostatic interaction.

Considering that the invariant inverse cube law of magnetostatic interaction should rightly be understood as just as fundamental as the invariant inverse square law of electrostatic interaction, or the invariant speed of light in vacuum, for example, it seemed important to proceed to such an experiment to irrefutably confirm the physical reality of this fundamental law which is mandated by de Broglie's hypothesis regarding the possible internal dynamic structure of photons ([5], p.277), which is at the origin of the development of the expanded 3-spaces geometry model ([2]) ([6]).

To that purpose permanent magnets were used, that naturally produce such fields. These results were alluded to in 1999 ([1], p.47) in a different context, and the details of how it was carried out were published in 2000 ([6], Appendix A), and are reproduced here in this separate paper.

Regular thin loud-speaker donut shaped magnets seemed ideal to carry out such an experiment since they are always magnetized parallel to thickness[1] for the loudspeaker coil to travel easily. This means that both north and south poles of their associated bipolar magnetostatic field behave as if they physically coincided and thus obeyed far field interaction law, which will be borne out by the data that we will collect. Since controlling such an experiment is very difficult when magnets attract, all observations were carried out with magnets placed in a position to repel each other.

A relative polarity reversal between two such magnets (placing them so that they attract or alternately repel) amounts to a 180^o spherical reversal of the fields with respect to each other within magnetostatic space ([2])([6]), which parallels to a high degree the manner in which two electrons would meet while one was in its expansion phase in magnetostatic space and the other was in its recession phase, in the 3-spaces model.

This is not without reminding of Heitler and London's observations in 1927 regarding the state of relative parallel and anti-parallel spin orientation of electrons to explain covalent bounding ([5], p.264) according to which "*if the spins of 2 electrons are of the same orientation, the exchange energy corresponds to a repulsion between the atoms… but if contrariwise both spins are of opposite orientation, the exchange energy corresponds to an attraction which for a very small distance between the two atoms, cancels out and becomes a repulsion if the atoms get nearer yet to each other* "; as well as the natural distribution of electrons by pairs in atoms' orbitals according to the Pauli exclusion principle ([3], p.219), according to which for two electrons to be able to occupy the same spatial orbital, both must have opposite spins.

Interestingly, with regards to Heitler and London's conclusions on the covalent link, it seems that the only possibility for two electrons to so paradoxically attract when they are at very short distance from one another despite their mutual electrostatic repulsion (that obeys the inverse square law), would be that another force simultaneously be at play locally, that would obey a higher order exponential law than the inverse square law. We will shortly verify that the inverse cube law of magnetostatic interaction perfectly matches that criterion.

Consequently, it seems possible to draw a rather direct parallel between the macroscopic bipolar magnetostatic fields of such circular magnets and the bipolar magnetic fields of electrons that are associated to the property named "spin" since electrons behave as point-like particles, which

[1] The magnets used were made of by Arnold Magnetics Ltd. Part Number 29375, ceramic ferrite, magnetized parallel to thickness.

means that both poles of their own magnetostatic fields can only likewise coincide.

But since referring to a possible mutual "relative orientation" of electrons implies localization, which would be in contradiction with the current Copenhagen philosophy view of electrons as being spread out in space as they move (wave packet, uncertainty principle) or as they vibrate or move in atoms, little if any information is readily available on the spin versus magnetic orientation correspondence in current physics textbooks, most if not all of which were written with the Copenhagen school philosophy in the background. This is why most physicists speak of spin as being "only a quantum number" specific to Quantum Mechanics and tend to dissociate it from the magnetic aspect of electrons.

$$\frac{\mu_B}{S_z} = \frac{e}{m} = \text{Classical Bohr gyromagnetic moment, meaning that} \quad \mu_B = \frac{eS_z}{m}$$

Although even in QM, spin is associated to the magnetic moment of charged particles, it is seen by most physicists as a simple, and practically mechanical, angular momentum ($S_z = \pm\frac{1}{2}\hbar$). This is why, to avoid dealing with this apparent inconsistency between theory and experimental reality, physical magnetic parallel and anti-parallel association of electrons is generally treated separately, typically only in texts discussing the properties of magnetic materials, and with very little if any reference to QM.

A good example of such a text is the chapter on Properties of Magnetic Materials of the **CRC Handbook of Chemistry and Physics** ([4], p.12-117), that leaves no questions unanswered regarding the nature of the physical spin of electrons. We will see further on however that in this proposed expanded space geometry ([2])([6]), it is perfectly possible to reconcile the presence of the localized magnetostatic fields of electrons with Quantum mechanics.

Except for German speaking countries, were these effects are frequent college experimental projects, there seems to be a world wide absence of information in undergraduate as well as in graduate level textbooks on the experimentally verified relation between forced parallel spin orientation of unpaired electrons at the particle level and the resulting macroscopic angular momentum observed in experiments conducted with ferromagnetic materials, let alone even mention of the names of very interesting effects. They are the **Einstein-de Haas effect** and the reciprocal **Barnett effect**. Given that no mechanical explanation coherent with QM has ever been found to explain macroscopic magnetism at the atomic level ([11], p. 655), one can only regret such widespread neglect of so fundamental information.

The only brief mention of these two important effects that I know of in a formal textbook is to be found in a textbook from a series written by Lev Landau et al., Nobel prize and member of the former USSR Academy of Sciences ([12], p. 129 (p.195 in the original Russian edition)). We will discuss these two effects in a separate paper ([13]).

The scatterable elementary particles making up nucleons (point-like quarks up and down) also having spin since they also are electromagnetic in nature, it is not unreasonable to think that it may be the electromagnetic interactions equilibrium between nuclei and electrons that would force the latter to magnetically orient only in two possible ways on their layers.

Once an isolated electron is captured and electromagnetically stabilized on a layer, whatever magnetic orientation the nucleus and other electrons in the atom force it to maintain, the only way a second electron can now fill that layer is to switch to anti-parallel orientation to associate with it, otherwise it will be repelled as concluded by Heitler and London. This amounts to physical quantization of the spin, since only two relative orientations are physically possible.

Of course the question comes to mind as to whether two free moving electrons can associate in this manner. Experimental reality reveals that the answer is no, the reason being that electrostatic repulsion obeying the inverse square law of distance and magnetostatic interaction presumably obeying a higher order inverse exponential, electrons have to be so close to each other for the magnetic interaction to dominate and this can really occur only when one of the electrons is physically captive in an atom and consequently cannot escape the encounter when sufficiently low energy for capture is present.

To get back to our loudspeaker circular magnets, another interesting feature of such magnets is that their magnetic poles, on top of coinciding with each other, also coincide with the geometric center of the magnet.

At this point, the reader may wonder at the usefulness of such an experiment. Let us consider that given that all elementary particles whose existence can physically be verified through scattering (photon, electron, positron, quark up, quark down, muon, tau) behave as if they were point-like particles, it can only be concluded that, without exception, both poles of their own respective magnetic fields mandatorily coincide by structure, as is the case with thin donut shaped circular magnets.

Consequently, the interest of this experiment lies in the fact that it allows verifying at our scale, directly on the lab bench, the behaviour of the only possible discrete magnetic field configuration that can exists at the physically scatterable point-like elementary particles level!

Although this is not the generally accepted view, we will assume here that we will not be measuring the law of interaction between the physical magnets themselves, but rather the law of interaction between the magnetostatic fields that are produced by these magnets.

Technically speaking, it is said that the field produced by a permanent magnet is **magnetostatic** since it is constant and does not vary in intensity. It is constant because it is produced by a particularly stable configuration of certain electrons of the atoms that are prisoners of each other in mutual forced parallel spin orientation in the material the magnets are made of that forces the field of each of the involved electrons to add up and become detectable at our level as macroscopic magnetic fields. Consequently, that field does not appear only when the magnets approach each other, but is by nature always present since the electrons that produce it have a permanent existence.

The electrons of the external electronic layer of atoms, that is the valence electrons, do not play any role here. These outer layer valence electrons are primarily involved in linking atoms into molecules by anti-parallel spin alignment by pairs of valence electrons (one valence electron being contributed by each atom involved), which results in a mutual cancellation of magnetic fields of the electrons of each of these pairs. The stable macroscopic magnetostatic fields of magnets are caused by forced parallel alignment of the spins of some unpaired electrons in the internal electronic layers of atoms.

The apparently undifferentiated nature of *quantized kinetic energy*, the "fundamental material" that the 3-spaces model reveals elementary particles to be made of, is such, that the individual fields of forced parallel spin aligned unpaired electrons seem to simply join each other and add to each other as if they became a single larger entity, somehow metaphorically like rain drops will join to form pools in which it becomes impossible to distinguish individual drops.

In the case of the magnetostatic field of our magnets however, a quantity of the overall field equal to that provided by each electron obviously remains intimately rooted in each of the participating electrons, since if we grind a magnet into dust and if we then separate this dust, it has been experimentally observed that each grain becomes a weaker magnet in comparison to its size, with respect to the size of the original magnet. In other words, each electron takes back its marbles, so to speak, and the global field gives way to as many smaller fields as there are individual grains of magnet dust.

If a magnet is heated, the magnetically aligned unpaired electrons of the internal layers become charged with an energy that causes them to vibrate on their orbits, a vibration that will affect the alignment of their spins, which will progressively modify their configuration to the point when the associated macroscopic magnetostatic field ceases to be perceptible.

When the magnet is cooled, the macroscopic field will reappear inasmuch as the heat did not permanently alter the molecular configuration that allowed it, meaning if the spins of electrons in the internal electronic layers that made up the initial macroscopic field become parallel again in the same manner.

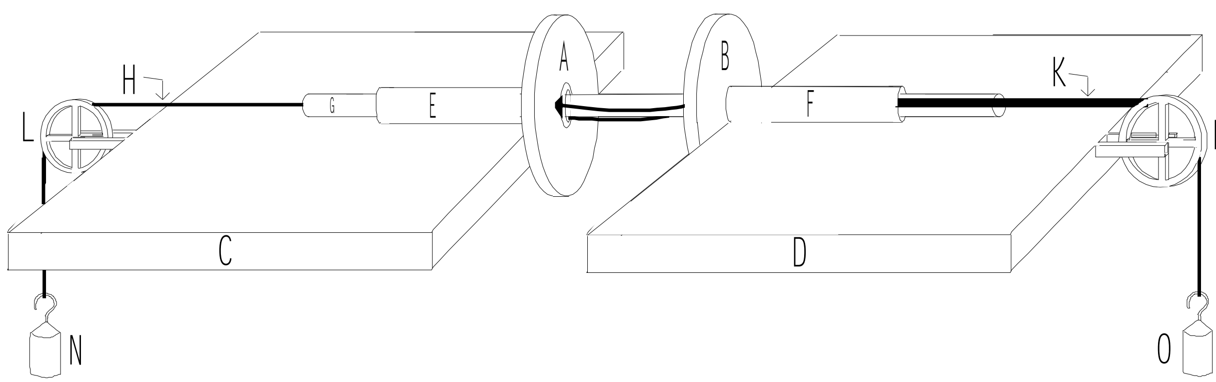
In other words, when we manipulate a permanent magnet, we directly manipulate, at our scale, an enormous magnetostatic field which is the very material that electrons are made of.

I - The Experiment

The following physical set up forces the magnets to remain as perfectly aligned and as parallel to each other as possible, which allows mentally visualizing both magnetostatic fields as if they were two invisible perfectly elastic spherical "objects" that physically occupy volumes in space extending beyond the physical body of each magnet.

The maximum experimental limit of proximity will be reached when the physical volume of the magnets will prevent reducing further the center to center distance between the fields.

Let us examine the equipment that was used:



A and B: Circular ceramic loudspeaker magnets[2] dimensions: Outer diameter 7.1 cm; Inner diameter 3.1 cm; thickness 0.84 cm; magnetized parallel to thickness. Manufactured by Arnold Engineering Co., Part Number 29375.

C and D: Styrofoam floating rafts 22 cm X 15 cm that must be floated on water deep enough to allow masses N and O to hang freely without touching the bottom of the container used.

[2] In schools where the SRP Air Cushion Table is being used to teach classical mechanics, teachers will recognize the pair of circular magnets or magnetic pucks, as well as the pulleys that are accessories of the apparatus.

E and F: Guiding tubes fitted perpendicularly inside the inner hole of each magnet. Tube E is fitted to magnet A and tube F is fitted to magnet B.

G: A 30 cm guiding rod loosely fitted inside both tubes E and F that insures that both magnets remain as perfectly aligned and parallel as possible at all times.

H and K: 30 cm threads holding masses N and O that pull the magnets towards each other. One end of thread H is securely fastened between tube F and magnet B and let to slide freely between guiding rod G and the inside of guiding tube E. The other end hangs freely down over edge pulley L.

Similarly, one end of thread K is securely fastened between tube E and magnet A and let to slide freely between guiding rod G and the inside of guiding tube F. The other end hangs down freely over edge pulley M.

N and O: pairs of equal size masses, the sum of which makes up the total mass noted in column P of the following table.

As many different size pairs of equal masses as required can be used to obtain as many measurements as the experimentalist wishes.

After each pair of masses is put in place, the whole floating assembly is delicately shaken as the floating rafts are re-balanced horizontally by means of secondary masses placed in the corners of the rafts to remove any stress between the guiding rod and the inside of the guiding tubes.

Once the assembly is stabilized with the guiding rod sliding as freely as possible inside the guiding tubes, a straight edge ruler is used to measure the distances between the magnets at 3 points located at 90º from each other on the outside circumference of the magnets: on both sides, and also on the top edge.

The distance between the lower edges of the magnets, which is located below water, is triangulated from the distances already obtained from the first 3 measurements. To take into account that each field is most intense at the geometric center of the magnets, the thickness of one magnet is added to all four measurements to insure true "center-to-center" measurement between the fields. The distances posted in column **r** of the table is the mean distance calculated from these 4 measurements.

Table of Measurements of Repulsion between 2 Loud-speaker Circular Magnets

	P	F=P x 9.80665 N	r	P x r^3	P x r^2
1	.05 kg	0.4903325 N	.1 m	5.000000 E-5	5.00000 E-4
2	.13 kg	1.2748645 N	.076 m	5.706688 E-5	7.50880 E-4
3	.21 kg	2.0593965 N	.063 m	5.250987 E-5	8.33490 E-4
4	.33 kg	3.2361945 N	.057 m	6.111369 E-5	1.07217 E-3
5	.41 kg	4.0207265 N	.05 m	5.125000 E-5	1.02500 E-3
6	.49 kg	4.8052585 N	.047 m	5.087227 E-5	1.08240 E-3
7	.57 kg	5.5897905 N	.046 m	5.548152 E-5	1.20612 E-3
8	.65 kg	6.3743225 N	.0445 m	5.727873 E-5	1.28716 E-3

In this table, the first column gives the amount of mass (the pressure) in kg (**P**) that was required to maintain the magnets at distance (**r**) in meters (center-to-center of the thickness of each magnet) that appears in the third column, and an inverse cube relation between pressure and distance can be represented by the following generic formula:

$$\mathbf{P = 1/r^3}$$

This relational formulation however, although traditional, hides a very important aspect of the relation, which is the fact that the product of a pressure by the third power of a distance is a constant. In the present case, this constant will be a number allowing calculating the distance at which the magnetostatic fields of the magnets stabilize to counteract a pressure as a function of the inverse cube law of distance. So we could tentatively name this constant *magnetostatic equilibrium constant*. The actual relation is then much more clearly represented if the formula is reorganized in the following manner

$$\mathbf{P \times r^3 = \text{Magnetostatic equilibrium constant}}$$

The 4th column in our table contains the results of applying this last formula to the raw data from the first and third columns. Observation will show that despite important fluctuations due to the very rudimentary means that were available to conduct the experiment and gather the data, and even with as few as these 8 readings[3], the values obtained clearly hover about an approximately constant level.

Another telltale that a cubic relation is involved comes from observing lines 1 and 5. We observe that as the distance in line 5 is half that of line 1, the mass used needed to be 8 times that of line 1, which is consistent with a force increasing with the cube of the distance. Consequently, the following first draft generic equation, involving a spherical relation between 2 "magnetic masses", so to speak, seems appropriate to represent the interaction that we just verified between our two magnets.

$$E = \mathbb{G}_? \frac{3{M_m}^2}{4\pi d^3}$$

where M_m symbolically represents the magnetic intensity of each magnet, that is, the magnetic moment of each magnet, usually symbolized by μ, $\mathbb{G}_?$ represents a magnetic constant that should obviously be μ_0, and $4\pi d^3/3$ which is the equation used to establish the volume of a sphere represents the spherical interaction over distance d, that is the interaction as a function of the inverse cube of the distance.

At this point, a dimensional analysis reveals that as it stands, the equation will provide only an energy in Joules, which confirms that on top of the inverse cube relation, we need to divide our equation by the center to center distance between the two magnetic spheres to really obtain a "force" in Joules per meter (J/m), that is, in Newtons. From these considerations, we can now write the final equation giving the intensity of the force between our two circular magnets at any given distance d from each other.

3 The reason for only 8 readings to have been noted during this experiment is linked to the difficulty involved in taking readings with masse smaller than .05 kg and larger than .65 kg with the apparatus being used. Masses smaller than .05 kg were too light, relative to the friction inherent to the system, which did not allow even the most delicate shaking and re-balancing of the floating rafts to stabilize at a sufficiently constant distance for the mass being used. A mass of .05 kg was the smallest mass that did allow such relatively constant distance to be obtained over 10 fold retries. All readings noted from .05 to .65 kg are means taken for 10 fold retries with each mass. As for masses larger than .65 kg, the readings became uncertain on account of warping of the delicate pulley-raft junction that begins to be noticeable with such masses.

$$F = \frac{3\mu_0\mu^2}{4\pi d^4} \qquad (1)$$

Let us compare it to the standard equation for calculating the force between equal force bar magnets[4] being approached parallel to each other and whose poles within each magnet are evidently at some distance l from each another (contrary to our circular magnets where this distance l is zero by structure) and whose distance between the bars (d) must be larger than l ([11], p 93) which is a given with our circular magnets since that in their case, they geometrically coincide :

$$F = \frac{3\mu_0\mu^2}{2\pi d^4} \quad \text{which is of course the same as} \quad F = \frac{3\mu_0\mu^2}{4\pi d^4} + \frac{3\mu_0\mu^2}{4\pi d^4} \qquad (1a)$$

We immediately observe that the force obtainable for bar magnets is double that which we experimentally obtained with our donut shaped magnets.

Let us recall that two bar magnets involve 2 separate pairs of poles, each pair being physically separated by distance l within each bar magnet, in constant separate interaction, and that our two circular magnets, although also involving 2 pairs of poles, behave as if each pair within each circular magnet coincided with the geometric center of the magnet, meaning that the corresponding distance l between opposite poles inside a bar magnet reduces to zero in the case of a loud-speaker donut shaped magnet.

This difference highlights a very important fact, because even if we found a way to reduce to zero the distance l between the poles of one bar magnet, we would logically expect that the force calculated in an experiment involving two such bars would still be double even when length l reaches zero inside each bar since the 4 poles would still theoretically be deemed to be statically present according to classical electromagnetism, whereas our experiment confirms that this is not the case with loud-speaker donut shaped magnets, whose poles of each magnet behave as if they precisely coincided (length l=0).

This behaviour precisely confirms that in the case of our circular magnets, where the “opposite poles” within each magnet geometrically coincide, **both north and south poles within such a magnet are not simultaneously present** but act in alternance and not simultaneously, which can be explained only by an alternance in the motion of the "magnetic" energy involved between a spherical expansion and regression as implied by the present model; at a frequency that obviously depends on the energy of the particle that produces it, presumably the carrying energy induced at the orbital on which the unpaired contributing electrons reside.

---

[4] A note of highly particular interest in the case of this recognized “standard equation” (1a) for bar magnets interaction is that nowhere is there explained how it can be derived from any classical theory whatsoever, contrary to the Coulomb equation which can easily be derived from Maxwell’s first equation.

This leads to believe that it was simply extrapolated from experiments such as this one, and was quoted on account of its conformity to experimental observation even though it turned out to be impossible to derive it from Maxwell’s electromagnetic theory, which requires only the inverse square electrostatic interaction to fully support a macroscopic wavelike description of observable macroscopic electromagnetic phenomena.

The magnetostatic inverse cube interaction becomes obvious however and becomes axiomatically required when dealing with electromagnetic energy as localized discrete electromagnetic events such as photons and stable massive elementary electromagnetic particles, such as electrons, quarks up, quarks down, muon and tau particles.

Consequently, despite the fact that it is mentioned in the Halliday & Resnick textbook, it turns out to still be entirely empirical and be supported by no classical theory whatsoever!

If we transpose this alternating dipolar behaviour to the elementary electromagnetic particles level, that obey the same rule by similarity due to their point-like nature, it also confirms that **the magnetic aspect of elementary electromagnetic particles is monopolar by structure at any given instant** and that it can only be the high frequency alternating rate of expansion-regression in magnets where the poles do not coincide that causes the magnetic aspect of the associated macroscopic magnetic fields to appear as being statically bipolar, and behave at the macroscopic level in accordance with near fields rules. In other words, ***contrary to electric monopoles (opposite sign charges) that can be observed separately in space, magnetic monopoles can be separated only in time***. **Paradoxically, this means that at any given instant, loud-speaker circular magnets interact as if they were separate magnetic monopoles**.

It is well established that a pressure of 1 kg being applied to lift a 1 kg mass corresponds to a force of 9.80665 Newtons being applied to offset the 1g gravitational acceleration at mean sea level. This allows calculating the force corresponding to each mass that we used during our experiment (second column of the table).

The magnetic moment of a magnet (μ) being defined in Joules per Tesla (J/T), and starting from previous equation (1), we can now calculate the magnetic moment of each of our circular magnets, that we assume to be identical. Isolating μ in (1) and using the values from columns **F** and **r** of line 1 of our table, we obtain the following approximate value :

$$\mu = \sqrt{\frac{4\pi r^4 F}{3\mu_0}} = \sqrt{\frac{4\pi (.1)^4 0.4903325}{3\mu_0}} = 12.78452841 \text{ J/T}$$

Assuming that the magnetic material of the magnets is made of atoms all having the same local dipole moment, the dipole moment of each magnet would be made up of the sum of these local dipole moments. Further assuming that only one electron per atom contributes to the field, then μ would be the sum of the magnetic dipole moments of the carrying energy of each of these electrons that in turn depends on the energy level of the orbital to which it belongs.

A few calculations with arbitrary distances and magnetic intensities of equal "magnetic masses" will show that the increase in force effectively numerically obeys the inverse cube law and that for each halving of a distance, the force will be multiplied by 8 as our experiment reveals. Let's remember that we postulated that these magnets were the physical anchoring sites of two spherical magnetic fields that extend beyond the magnets.

And now that we know the magnetic moment of our magnets, we finally are in a position to calculate the intensity of the magnetic fields of our experimental magnets at any distance from their geometric center along the axis normal to their surface. We established in a prior paper ([7], p.8, equation (35)) a neat relation involving only magnetic moment (μ), corresponding energy (E) and corresponding magnetic field (**B**)

$$\mu = \frac{E}{2\mathbf{B}} \quad \text{in which we can isolate } \mathbf{B} \quad \mathbf{B} = \frac{E}{2\mu} \tag{2}$$

From equation (1) we can easily establish the equation for the energy corresponding to this dipole moment

$$E = Fd = d\frac{3\mu_0\mu^2}{4\pi d^4} = \frac{3\mu_0\mu^2}{4\pi d^3}$$

If we now substitute this definition of E in equation (2)

$$\mathbf{B} = \frac{E}{2\mu} = \frac{3\mu_0\mu^2}{2\mu 4\pi d^3} = \frac{3\mu_0\mu}{8\pi d^3} \quad (3)$$

Making use again of the value of **r** from line 1 of our table, we obtain the intensity of the magnetic field in Tesla when the magnets are 10 cm from each other

$$\mathbf{B} = \frac{3\mu_0\mu}{8\pi d^3} = \frac{3\mu_0\mu}{8\pi(.1)^3} = 1.917679279\text{ E} - 3\text{ T}$$

Now with the value of **r** from line 5 of the table, that is 5 cm from each other

$$\mathbf{B} = \frac{3\mu_0\mu}{8\pi d^3} = \frac{3\mu_0\mu}{8\pi(.05)^3} = 0.015341434 \quad \text{T}$$

which is exactly 8 times the field intensity that we just calculated for a distance of 10 cm, thus definitely confirming the inverse cube magnetic relation? We finally are in a position to establish the maximum magnetic field intensity of our magnets when both magnets are in physical contact. The thickness of one magnet being 0,84 cm, the distance center to center of both associate fields is then 0,84 cm, or 8,4 E-3 m.

$$\mathbf{B} = \frac{3\mu_0\mu}{8\pi d^3} = \frac{3\mu_0\mu}{8\pi(8{,}4\text{E} - 3)^3} = 3.235475484 \quad \text{T}$$

Now back to the elementary particles level, Paul Marmet did a remarkable exploration of the relation between the magnetic aspect of electrons and its contribution to the electron mass, which he termed the "magnetic mass". Starting with the Biot-Savart equation in which he quantized the charge in the definition of electrical current and did away with the time element by substituting dt = dx/v since a any given instant, the velocity of current is constant, he obtained the following definition for current.

$$I = \frac{dQ}{dt} = \frac{d(Ne)}{dt} = \frac{d(Ne)v}{dx}$$

where e represents the unit charge of the electron and N represents the number of electrons in one Ampere. By substituting that value of I in the scalar version of the Biot-Savart equation,

$$dB = \frac{\mu_0 I}{4\pi r^2}\sin(\theta)dx\,, \quad \text{he obtained} \quad dB = \frac{\mu_0 v}{4\pi r^2}\sin(\theta)\,d(Ne)$$

Without going into the detail of his derivation, which is very clearly laid out in his paper ([8], p 1 to 7), let us only mention that the final stage consists in spherically integrating the electron magnetic energy, whose density is mathematically deemed to vary radialy from a minimum corresponding to r_e to infinity.

$$M = \left\{\frac{\mu_0 e^2 v^2}{2(4\pi)^2 c^2 r^4}\right\} 2\pi \int_0^{\pi} \sin(\theta)d\theta \int_{r_e}^{\infty} r^2\, dr$$

The electron classical radius r_e is the mandatory inferior limit in such a case of integration to infinity, due to the simple fact that integrating any closer to r=0 would accumulate more energy than experimental data warrants. This constraint also seems to be the only reason for the existence of this "classical radius" of the electron. After integrating, we finally obtain

$$M = \frac{\mu_0 e^2 v^2}{8\pi r_e c^2} = \frac{m_e}{2}\frac{v^2}{c^2}$$

that very precisely corresponds to the total mass of the magnetic field of an electron moving at velocity v, whence one can conclude that the invariant magnetic field of the electron at rest will correspond to a mass of

$$M = \frac{\mu_0 e^2}{8\pi r_e}$$

which is exactly half the mass of an electron, the other half being made up of its electrostatic mass.

But let's get back to our table. As a reference with respect to the inverse square law which is often mistakenly considered to apply in magnets interaction, the fifth column in our table represents the figures obtained when applying **P x r² = Constant** to the raw data that was experimentally obtained. It should be obvious that the figures in that fifth column do not tend to hover about an approximately constant level, but increase as the distance shortens between the magnets, thus clearly demonstrating that the inverse square law does not apply.

If we now consider again the first relational equation that we derived from experimental data (**P x r³ = Magnetostatic equilibrium constant),** we observe that the dimensions involved are **kg•m³**, and ignoring the two most extreme values measured (line 1 and line 4), our table allows establishing a first approximation value of this constant for our two magnets at **P x d³ = 5.4076545E-5 kg•m³**. This constant now allows easily calculating in a simplified manner the pressure to be applied at any distance and vice-versa that we care to consider between these two magnets. Equation **F=Pg** of the second column will then allow calculating the related force, and finally, equation **E=Fd** will give the related energy in joules.

II - The Electron-Nucleon Magnetic Relation

The reader may already have drawn a parallel between these equilibrium states of our magnets and another equilibrium state, at the level of elementary particles that has mystified scientists for a century. Could such an equilibrium state finally explain why escorting electrons cannot crash on their own on atomic nuclei, despite the electrostatic attraction that seems to mandate such crashing, but that observation clearly proves cannot happen?

Scatterable elementary particles having both an electric aspect (that obeys the inverse square law of distance) and a magnetic aspect (that obeys the inverse cube law of distance as we have just analyzed), one could easily surmise that the states of equilibrium of electronic layers in atoms could possibly involved magnetostatic interaction on top of the well understood electrostatic interaction!

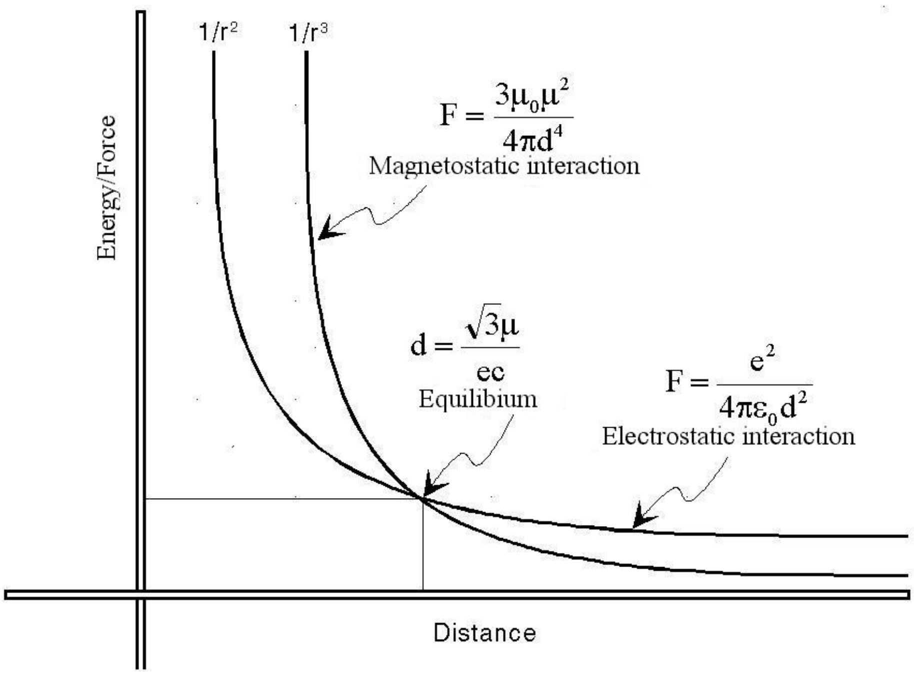
What if in a hydrogen atom, as the electron comes closer to the proton, the mean magnetic interaction between proton and electron became repulsive for reasons to be identified and repelled it, while if it got farther away, the electrostatic attraction would dominate again, bringing it back so that the motion of the electron generally stabilized about a mean equilibrium distance, that would of course be the well known Bohr radius, within the statistical spread predicted by Quantum Mechanics?

It goes without saying that such an electromagnetic equilibrium distance specific to each electrons-nuclei configuration could exist only if the magnetic interaction between nuclei and electronic escorts could only be exclusively repulsive (never attractive).

In this regard, the spherical expansion-regression dynamic structure of elementary particles magnetic behavior predicted by the 3-spaces model and strongly supported by this circular magnets experiment, does offer a wonderful surprise! **We will now see that in this model, the magnetic interaction between nucleons and electrons <u>can only be exclusively repulsive</u>!**

Two different approaches can be considered in context, depending on the manner in which we chose to consider the extent of magnetostatic interaction in space as a function of the inverse cube of distance. In both cases however, the same reason would explain why electrons can only be magnetically repelled by atomic nuclei.

The first is the traditional purely mathematical approach based on the premise that this interaction would act to infinity like electrostatic interaction, while the second (more natural at the physical level in the present model) is based on the premise that this interaction would not extend beyond the maximal physical extent of the energy sphere (whose extent in magnetostatic space depends on the amplitude as a function of the frequency of the particle, with the speed of light standing as the absolute maximum speed the energy making up the particle can travel even within the particle's internal dynamic structure) of a particle, meaning that no magnetic interaction would occur between two particles unless their constantly expanding and contracting magnetic energy spheres enter into physical contact with each other. We will develop the demonstration from the first possibility, which is simpler to elaborate.



Let us first put in perspective a few points that we have previously analyzed regarding the Bohr hydrogen atom. For the electron, we are dealing with two distinct electromagnetic quantities, the electron proper with its 510,998.9 eV rest mass energy and its carrier-photon ([7]) with its 27.2 eV energy. Given that a first approximation will be more than sufficient to explain the mechanics of the phenomenon, we will take into account only the magnetic field of the electron since that of its carrier-photon is relatively negligible.

As for the proton, the situation is much more interesting, and somewhat unexpected! While the energies of the two up and one down quarks are respectively 1,149,747.5 eV and 4,598,990.2 eV, their three carrier-photons each have an energy of 310,457,837 eV as determined in chapter **The Internal Structure of the Triad** ([6]), which represents approximately 300 times more energy than that of the particles that they carry, which means that here, it would be the invariant rest mass energy of the quarks themselves that is negligible!

The minor contribution of the valence quarks (up and down) to the proton spin has in fact been demonstrate in 1995 at the S.L.A.C. facility, which is coherent with the valence quarks being much less energetic than their carrier-photons as this model indicates. This means, if we consider that magnetic interaction extends to infinity[5], thus that the more energetic fields determine the relation, and that **atomic electromagnetic equilibrium would be caused by electrostatic interaction being counterbalanced by the magnetostatic interaction between the invariant energy of electrons with the relativistic energy of the carrier-photons of the up and down quarks of nuclei**!.

This would *de facto* explain why equilibrium would be sensitive to possible variations of the relativistic energy of the carrier-photons as a function of the electrostatic interactions (gravitational interaction) of the quarks that they carry with the quarks making up the nuclei of neighbouring atoms that would determine the equilibrium distances between electrons and nuclei as a function of local matter density (see Chapters **Inside Planetary Masses** and **The Slowing Down of Atomic Clocks** ([6])).

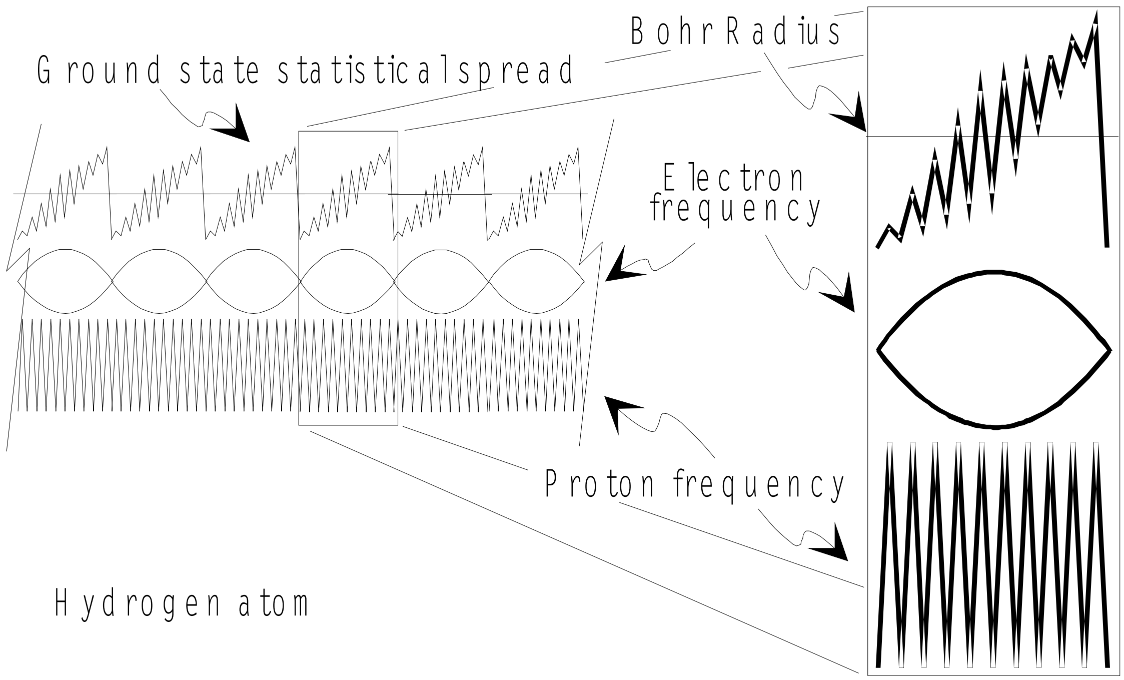
In an isolated hydrogen atom, one can conceive that the motion of the electron would not be inhibited and that it could, in the fundamental state, effectively move at the velocity that the energy of its carrier-photon allows, that is, 2,187,691.252 m/s (classical), which would cause it to cover for each orbit a distance of 3.32491846E-10 m (see Chapter **The carrier-photon** ([6])), as accounted for by the hydrogen nuclear wobble (10).

The absolute wavelength of the electron rest energy being 2.426310215E-12 m (see Chapter **The Mechanics of Conversion** ([6])), it is easy to calculate that the electron would cycle very precisely 137.0359998 times between magnetostatic space and normal space at each orbit, this value shows by the way that at each turn, the 137th complete cycle of the electron energy will terminate 8.734668247E-14 m before the corresponding cycle of the previous orbit. We would then be in a position to calculate very precisely at which point of its electromagnetic phase and at which point of the orbit an electron would be at any moment in the future by starting from any specific arbitrary point of the orbit.

Let us now consider the absolute wavelength of the carrier-photons of the up and down quarks, whose energy, in this model, is 310,457837 eV each, that is 4.974082389 E-11 Joules, which corresponds to a frequency of 7.506837869E22 Hz, and to a wavelength of 3.993591753E-15 m, which means that during each electromagnetic cycle of the electron, the energy of the carrier-photons of the nucleus cycle 607.5508879 times.

5 If magnetic interaction extended only as far as the transverse amplitude of particles' energy (see Chapter **The Mechanics of the Photon**), it could then be supposed that it would then be the magnetic field of the carrier-photon of the electron that would mainly interact with the up and down quarks, since it is these fields that have the largest amplitude and so would extend the farthest in space.

Let us now examine the following figure that represents an arbitrary segment corresponding to 6 of the 137 cycles that the rest mass energy of the electron will complete during one orbit, with an isolated segment representing one of these electronic energy cycles:



The upper sequence represents the axial travel of the electron about its average distance from the nucleus (the Bohr orbit). The central sequence represents the variation in intensity of the magnetic presence of the energy of the electron during each of its cycles. The lower sequence represents the 607.5508879 intensity variations of the magnetic presence of the nucleus carrier-photons that occur during each magnetic cycle of the electron. Obviously, the intensities (and number of cycles per second for the proton) are not represented to scale here, since the energy of each quark carrier-photon is 600 times greater than that of the electron, and that at least 2 of the carrier-photons of the proton are always in parallel spin with respect to the third, and that their energies consequently add up to correspond to 1200 times the energy of the electron.

Let us also remember that in this model, the presence of the energy of elementary particles in magnetostatic space varies during each cycle from zero to a maximum (a period during which it is repulsive) to then diminishes to zero (a period during which it is attractive). Looking at the isolated segment, one can easily visualize that at the beginning of the cycle of the electron, while the intensity of the magnetic presence of the nucleus increases in the first part of the first of its 607 cycles, thus coming in opposition to the magnetic presence of the electron which also is in its increasing phase, the latter, being very light with respect to the nucleus, will of course be repelled a certain distance with respect to the nucleus.

One can also easily understand that when the magnetic intensity of this first cycle of the nucleus will start diminishing towards zero thus becoming attractive, it will find itself in anti-parallel situation with respect to the electron magnetic presence which is still in its increasing phase, and that there will then be attraction between the electron and the nucleus.

And it is here that the mystery unravels, because, given that attractive and repulsive magnetic force obeys an exponential inverse interaction law with distance, the attractive force between proton and electron, which are now located further away from each other than when the repulsive force was applied during the first part of the cycle of the nucleus, will mandatorily be weaker starting at this farther distance, and thus **there will be a <u>physical impossibility</u> for the electron to be brought all the way back to the distance it was at at the beginning of the rising magnetic phase of the energy of the proton**, since the duration of the attractive phase is the same as that of the repulsive phase while the force being applied at the start of the attractive phase is less than that applied at the start of the repulsive phase!

The same situation being reproduced for each of the following 606 cycles of the nucleus carrier-photons magnetic presence, the result can only be a progressive motion of the electron away from the nucleus, made up of very precise to and fro motions until the intensity of the magnetic presence of the electron energy becomes too small and finally momentarily falls to zero, moment during which all magnetic interaction having disappeared, the electron will fall freely towards the proton as it now obeys the only force still active, the electrostatic force (obeying the law of inverse square of the distance), until the intensity of the magnetic presence of the energy of the electron becomes sufficient again at the beginning of the following cycle of the magnetic presence of the electron energy for the progressive repulsive interaction to start dominating again.

So, in this model, it is this phenomenon that, while forcing the electron to progressively occupy all of the physically possible locations of the statistical distribution defined by the equations of Quantum Mechanics, but within the limits imposed by the speed of light being the actual asymptotic limit velocity, maintains it in a stable manner at an average distance from the nucleus corresponding to the Bohr radius.

A fundamental question now comes to mind since such a zigzagging transverse motion of the trajectory seems to be the only mechanical possibility regarding the ground state of hydrogen when considering a permanently localized electron, since we know that electrons do not radiate energy when in the ground state. All the more so since the zigzagging motion just described can only be made more erratic yet in this bound state by continued action of the Zitterbewegung motion described in chapter **The Carrier-Photon** ([6]), caused by the interaction between the electron magnetic field and the magnetic field of its own carrier-photon.

How could such an obviously complex to and fro motion about the theoretically ideal Bohr ground orbit be reconciled with the electron not emitting energy at each transverse limit, since we know from high energy particle accelerator observations that transverse undulating or wiggling motion systematically causes release of bremmstrahlung synchrotron radiation ([9]), that is, one photon being released at each transverse stop of the undulating motion prior to re-accelerating in the reverse transverse direction as analyzed in Chapter **Four Types of Permanent Attractors** ([6]).

The answer to this question is quite simple in this model because in high energy accelerators electrons are force-accelerated way beyond their natural equilibrium states which causes them to shed that excess energy whenever any type of bremmsing (transverse or longitudinal forced slowing down) allows, while in their fundamental states in atoms, electrons remain at all times in their lowest energy states as they follow their apparently hectic least action trajectories (when allowed) or local fluctuating stationary states, as the local electromagnetic equilibrium constantly fluctuates as previously analyzed.

It does not then seem unrealistic to think that an appropriate mathematical development based on the mechanics of this model could one day allow calculating with great precision all future physically possible locations of a localized electron within the QM statistical distribution, with as a starting point any point of the orbital arbitrarily chosen that would lie within the boundaries set by considering the asymptotic speed of light as an absolute speed limit for the localized electron in relation with its inertia, thus putting an end to the unconditional reign of the Heisenberg Uncertainty Principle.

But let's come back to that other magnetic interaction possibility, that is, that based on the premise that this interaction would not extend beyond the maximum physical extent of the magnetic energy sphere of a particle, whose extent in magnetostatic space depends on the amplitude as a function of the frequency of the particle with the transverse speed of light as an absolute limiting factor, which, as previously mentioned, is more natural to the present model and more conform to Maxwell's theory, but would require that the lower limit of the Marmet equation be changed. In fact, it would require for the equation to take into account the cyclic translation of the energy between a magnetostatic maximum on one side and an electrostatic maximum for photons or alternately a normal space maximum on the other side for massive elementary particles.

III - The Electron-Nucleon Electromagnetic Equilibrium

The remaining question now is how do the various relations between the various fluctuating magnetic spheres involved in a stable hydrogen atom interact, each cyclically reversing its spin at its own frequency? And how can this explain all naturally occurring electric versus magnetic stability levels?

Much more research, experimentation and calculation than what can be laid out at this stage is required to completely clarify the issue. But we can definitely put in perspective the complete list of elements that must be taken into account.

The first such element regarding the hydrogen atom is that the ratio of the mean rest orbital distance of the electron to the proton versus the proton diameter being about ten thousand to one[6], the magnetic interaction between electron and proton obeys by structure the far fields interaction law, which means that their magnetic relation will obey the far fields equation (1) that we established previously

$$F = \frac{3\mu_0\mu^2}{4\pi d^4}$$

We also know from the now established fact that the resultant magnetic interaction between the electron and the various components making up the proton can only be repulsive to various degrees, irrespective of spin orientation, and that if this mean repulsive force is to exactly counteract the electrostatic attractive force, it will be exactly equal and opposite to the attractive force calculated with the Coulomb equation, so we can pose

$$F = \frac{3\mu_0\mu^2}{4\pi d^4} = k\frac{e^2}{{a_o}^2} = 8.238721759\,E-8\,N \tag{4}$$

---

[6] If for comparison we imagine the proton being the size of the Sun, then the electron would orbit it 30 times further away that the Earth, that is, as far as Neptune! Seen from Neptune, the Sun would appear point like, with no obvious diameter, just the brightest star in the Universe. For all practical purposes, such an atom would be as large as the entire Solar planetary system!

Since we know from experimental verification that the magnetic moment of the orbiting electron and that of the hydrogen nucleus are not equal, then the term μ^2 from equation (4) needs to be replaced by a representation reflecting this difference. So equation (4) will be rewritten as

$$F = \frac{3\mu_0(\mu_1\mu_2)}{4\pi d^4} = 8.238721759\text{E} - 8\,\text{N} \tag{5}$$

If we then isolate this product, now knowing the values of all other terms since $d = a_0$ by definition in equation (4), we can now obtain the numerical value of this product

$$\mu_1\mu_2 = \frac{F4\pi d^4}{3\mu_0} = 2.153491216\text{E} - 48\,\text{J}^2/\text{T}^2 \tag{6}$$

What remains to be done now is to clarify from theory the respective values of μ_1 and μ_2 for them to match the experimentally obtained values.

Defining the composite orbiting electron magnetic moment (μ_1)

It was clarified in a separate paper ([14]) how the experimentally measured value of the electron magnetic moment (μ_e) can be calculated from theory.

Summarily put, its theoretical classical value is calculated from the gyromagnetic moment equation mentioned at the beginning of this paper

$$\mu_B = \frac{eh}{4\pi m_o} = 9.27400899\,\text{E} - 24\,\text{J/T} \tag{7}$$

The same paper ([14]) clarified why this value, known as the "Bohr magneton", can only apply in physical reality to an electron moving in straight line with the same energy as that of an electron on a hydrogen atom rest orbital.

Actual measurements have conclusively shown that the real value of the so-called electron magnetic moment on a hydrogen atom rest orbital is noticeably higher than the theoretical Bohr magneton value. This measured value has been established to be 9.28476362 E-24 J/T within a relative standard uncertainty of ± 4.0E-10.

The reason for this difference, unexplained by current classical theories, becomes obviously in the 3-spaces model due to the simple fact that the electron on the hydrogen rest orbital can only move, if at all, in a closed circle about the nucleus, a circular motion that can be sustained only if the local magnetic field allows it by becoming higher than for straight line motion with the same energy, by a value that can be theoretically established from the 3-spaces model by a factor of 1.00161386535E-3 ([14], equations (11) and (13)), which is very close to the currently accepted factor, as we will presently see.

The 3-spaces model allows to clearly identify the natural phenomenon of **magnetic drift**[7] as the cause of this difference, that must be associated to all circular motions as well understood in high energy circular accelerators.

The manner in which the measured value is traditionally reconciled with the theoretical Bohr magneton has been to multiply the latter by an ad hoc factor named *the g factor of the electron*, whose definition lies beyond the scope of this paper, but whose value, theoretically set at 2 for other purposes, is further adjusted after the fact to fit the measured magnetic moment value, so to speak, to g/2

[7] An increase of the local ambient magnetic field associated to a corresponding decrease of the local ambient electric field proportional to the gyroradius of the closed orbit involved ([14]).

=1.001159653 from the ratio of the actual measured value to the theoretical Bohr value, to account correctly for the experimentally measured value of the electron magnetic moment in the hydrogen atom. So

$$\mu_e = \frac{g}{2}\frac{eh}{4\pi m_o} = 9.28476362\,E-24\ J/T \tag{8}$$

A note of interest before pushing further is the conclusion drawn in a separate paper ([7]) that the Bohr magneton (**μ_B**), does not involve in any way the rest mass energy of the electron but rather exactly half of the **added electron carrying energy** induced at the Bohr rest orbit ([7], equations (26), (27) and associated footnote), **cannot possibly be a property of the electron proper**, **but rather a property of its added carrying energy** as induced at the Bohr radius. And consequently, the so-called electron magnetic moment (**μ_e**), involving to the same amount of added energy electromagnetically distributed in such a way that its local magnetic field is increased to account for the circular motion obviously **also is a property of the added carrying energy**.

But while the measured electron magnetic moment (**μ_e**) has been shown to be sufficient to account for the circular motion of the electron at the rest orbital gyroradius ([14]), there is need to also take into account the intrinsic magnetic field of the electron rest mass proper to fully account for actual repulsive relation between the orbiting electron and the central nucleus, particularly since the electromagnetic energy captive of the electron rest mass is much larger than the added amount of carrying energy induced at the Bohr orbit, the latter fully accounting for the measured so-called electron magnetic moment (**μ_e**).

But before we can calculate the actual electron rest mass magnetic field, which is the other component of the composite orbiting electron magnetic moment **μ_1**, we need to first establish the value of the proton magnetic moment which will be equal by definition to **μ_2** in equation (4), since in the far fields perspective, the hydrogen atom nucleus will be dealt with as if it was a point like particle.

Defining the corresponding hydrogen nucleon (proton) magnetic moment (μ_2)

Historically, the value of the hydrogen proton magnetic moment is theoretically approximated in a manner similar to that of the Bohr magneton (see equation (7)), by replacing the mass of the electron by the mass of the proton, so

$$\mu_N = \frac{eh}{4\pi m_p} = 5.05078317E-27\ J/T \tag{9}$$

This value is named the *nuclear magnetic moment*. But, just like the measured electron magnetic moment, the proton magnetic moment proves to be higher than this calculated value, and quite considerably this time, by a so-called ad hoc *proton g factor* of 2.792775597.

The first measurements of the proton magnetic moment were conducted by Estermann, Frish and Stern in 1932. A confirming experiment, also involving Estermann and Stern, was conducted in 1937 and is put in reference ([15]) for readers interested in further exploration of this issue.

So, we traditionally obtain the actual measured value of the proton magnetic moment (**μ_p**) by multiplying the nuclear magneton (**μ_N**) by this ad hoc proton g factor, and since **μ_2** is equal to **μ_p** in equation (4), we can pose

$$\boldsymbol{\mu_2} = \boldsymbol{\mu_p} = \boldsymbol{\mu_N} \ \mathbf{x} \ 2.792775597 = 1.410606633\text{E-}26 \text{ J/T} \qquad (10)$$

Which is the actual measured hydrogen atom nucleus magnetic moment. This magnetic moment of the proton however can only be the resultant of the combined magnetic interaction between the 2 quarks up, the single quark down and their 3 carrying-photons making up the scatterable structure of the proton. We will address this issue later.

Calculating the orbiting electron rest mass magnetic moment ($\boldsymbol{\mu_E}$)

Let us now rewrite equation (6) to account for the fact that $\boldsymbol{\mu_1}$ is a composite value made up of the so-called electron magnetic moment ($\boldsymbol{\mu_e}$), which can be shown to really be the electron carrying energy magnetic moment, plus the actual electron rest mass magnetic moment that we will symbolize by ($\boldsymbol{\mu_E}$)

$$(\mu_e + \mu_E)\mu_2 = \frac{F4\pi d^4}{3\mu_0} = 2.153491216\text{E}-48\,\text{J}^2/\text{T}^2 \qquad (11)$$

Isolating $\boldsymbol{\mu_E}$, we obtain the real electron rest magnetic moment

$$\mu_E = \frac{F4\pi d^4}{3\mu_0\mu_2} - \mu_e = 1.526829964\text{E}-16\,\text{J}^2/\text{T}^2 \qquad (12)$$

Calculating the orbiting electron rest mass magnetic field ($\mathbf{B_e}$) and effective cross-section

From ([7], equation (25)), we know that the magnetic field of an elementary particle can be calculated by dividing half of its rest energy by its magnetic moment, so

$$B_e = \frac{E}{2\mu_E} = \frac{8.18710414\text{E}-14}{2\times 1.526829964\text{E}-16} = 268.1079208\,\text{T} \qquad (13)$$

We can now obtain the corresponding energy density from

$$U_B = \frac{{B_e}^2}{2\mu_0} = \frac{(268.1079208)^2}{2\mu_0} = 2.860088223\ \text{E}10\ \ \text{J/m}^3 \qquad (14)$$

Since this density is a measure of energy over volume, we can now determine the actual volume within which the electron rest mass magnetic energy will oscillate at the rated frequency

$$V = \frac{E}{U_B} = \frac{8.18710414\text{E}-14}{2.86008823\text{E}10} = 2.862535517\text{E}-24\ \text{m}^3 \qquad (15)$$

Since this volume is spherical by definition, let us calculate the radius of this volume

$$r = \sqrt[3]{\frac{3V}{4\pi}} = 8.808205226\text{E}-9\,\text{m} \qquad (16)$$

Which is totally consistent with the orbiting electron magnetic field to clearly interact with that of the hydrogen nucleus, which is located at the slightly shorter mean distance of 5.291772083E-11 m (The Bohr radius).

Interestingly, the radius of the electron rest mass magnetic field (equation (16)) turns out to be practically equal to the absolute amplitude of the accompanying carrying energy of 4.359743805E-18 Joules induced at the Bohr ground state:

$$A = \frac{hc}{2\pi E_B} = 7.251632784E-9m \quad (17)$$

Now this concludes the overview of the factors required to eventually mathematically completely address the issue of the magnetic repulsion between the nucleus and the electron of the hydrogen atom that exactly counteracts their electrostatic attraction at a mean distance corresponding to the Bohr ground orbit.

The composite magnetic moment of the proton

As previously mentioned, the measured magnetic moment of the proton (see equation (10)), that is μ_p = 1.410606633E-26 J/T, can only be the resultant of the combined magnetic interaction between the 2 quarks up, the single quark down and the 3 carrying-photons making up the scatterable structure of the proton.

We just saw how to correctly calculate all aspects of the hydrogen atom magnetic repulsion between accompanying electron and nucleus that explains why it is impossible for the electron to crash on its own on the nucleus despite electrostatic attraction. There now remains to establish the same equilibrium relation between the components of the proton proper.

The hurdle in clarifying this issue relates to the difficulty in determining the specific energy density to be applied to the magnetic fields of each of these 6 components. From the analysis carried out in a separate paper ([7]), it would be quite easy to calculate the reference absolute energy densities of the elementary particles making up the proton. This absolute density however would apply only if each particle's energy was statically regrouped in the smallest sphere possible, which cannot possibly be the case for the constantly oscillating energy making up each particle.

But taking as a reference the density that we just found appropriate for the magnetic field of the orbiting electron, which is way lower than the reference absolute limit density, we can surmise that the energy density of the proton components will also be way lower than their absolute limit energy density.

For the electron rest mass magnetic field for example, we just saw (equation (13)) that the relative magnetic field of the electron rest mass turns out to be 268.1079208 T at the rest orbital mean distance from the nucleus, corresponding to an energy density (equation (14)) of 2.860088223E10 J/m^3, even though their respective absolute limit values would be

$$B = \frac{\pi\mu_0 ec}{\alpha^3 \lambda_C{}^2} = 8.289000221E13T \quad \text{and} \quad U = \frac{B^2}{2\mu_0} = 2.733785545E33 \ \text{J/m}^3$$

Again, let us emphasize that these absolute limits correspond to the maximum density of a theoretical sphere within which all of the electron's energy would be isotropically concentrated. Obviously, the pulsating magnetic energy of the real electron does not distribute in this manner, but rather as a sphere whose density would be maximum at the center and would decrease as a function of distance from the center up to a maximum distance that remains to be confirmed. The density obtained with equation (14) would thus simply be the density of the magnetic energy of the electron at the point of equilibrium between nucleus and electron, point that would of course be located between the nucleus and the mean electron rest orbital.

Now, what we can do as a first approximation of specific magnetic momenta of the proton inner components would be to take as a reference the mean energy density that can be associated with the measured proton magnetic moment (μ_p = 1.410606633E-26 J/T). For this purpose, we must calculate the total magnetic energy that is to be associated to this magnetic moment.

Since all components of the proton are translating on closed orbits, their individual magnetic moments will by definition be more intense than if the same particles were travelling in a straight line due to mandatory drift of the particles' carrying energy towards magnetostatic space as a function of their respective gyroradii, as clarified in a separate paper ([14]).

Let us first lay out a table of the energy of the various elementary scatterable particles making up the proton and their associated carrier-photons that need be considered as analyzed in ([6, chapter **The Internal structure of the Triad**]).

Knowing that frequency f = E/h and that wavelength λ = c/f, since amplitude A= λ/2π. We can thus write :

$$A = \frac{hc}{2\pi E}$$

Absolute Amplitudes of the proton constituting particles			
Particle	Energy (E)	Amplitude $\left(A = \frac{hc}{2\pi E} \right)$	Space Concerned
Up quark	1.842098431E-13 J	1.716263397E-13 m	Magnetostatic
Down quark	7.368393804E-13 J	4.290658445E-14 m	
Carrier-photon of each quark	4.974082389E-11 J	6.35599868E-16 m	
Proton Radius in normal space		1.252776701E-15 m	Normal
Coplanar Rotation Diameter		3.344237326E-13 m	Electrostatic

Eventually, the various integrated absolute amplitudes of the particles making up the proton and their gyroradii should allow calculating the physical extent of the magnetostatic energy spheres of the nucleon components within magnetostatic space.

Account must be taken however of the fact that the extent of these spheres is directly influenced by the **magnetic drift factor** described in a separate paper ([14]). We know already from experimental evidence ([6], chapter **The Internal structure of the Triad**) that this magnetic drift factor is 4/3 for the up quark and 5/3 for the down quark.

The quarks magnetic drift at their respective gyroradii implies that their magnetic fields involves a quantity of energy equal to that of a higher energy particles moving in a straight line. So let's calculate the increased total energy of the magnetically drifted particles.

$$\text{Up Quark total drifted energy} = E_u \times 4/3 = 2.456131241\text{E} - 13\text{ J} \qquad (18)$$

$$\text{Down Quark drifted energy} = E_d \times 5/3 = 1.228065634\text{E} - 12\text{ J} \qquad (19)$$

As for the three quarks carrier-photons which are moving in circle in normal space, the method defined in paper ([14]) makes it relatively easy to calculate this drift factor in relation with their gyroradius, the latter being 1.252776701E-15 m.

Considering that the three quarks form a rigid structure rotating about the normal space axis at a velocity determined by the energy of three carrier photons, we can add together the energy of the 3 quarks and treat this total quantity as a single particle being accelerated by the energy of the three photons:

$$E = 2E_u + E_d = 1.105259067\ E\text{-}12\ J \tag{20}$$

Likewise, we can add the energy of the three carrier photons and treat it as a single quantity

$$K = 3E_{c\text{-}p} = 1.492224717\ E\text{-}10\ J \tag{21}$$

Making use now of equation (2) from paper ([14]), let's calculate the magnetic drift factor of the three carrier-photons energy:

$$\text{magnetic\_drift} = \frac{\delta\mu}{\mu_B} = \frac{\sqrt{4EK + K^2}}{2\pi(2E + K)} = 0.159137985 \tag{22}$$

which means that the total energy of the 3 carrier-photons must be multiplied by 1.159137985 to account for the associated magnetic drift, so:

$$\text{Carrier - photons drifted energy} = K \times 1.159137985 = 1.729694352\,E - 10\,J \tag{23}$$

which makes the total equivalent magnetically drifted energy of the six components of the proton equal to the sum of the figures obtained from equations (18), (19) and (23), so

$$E = 1.74443114E\text{-}10\ J \tag{24}$$

which is a figure 16% higher than the actual energy of the proton rest mass. But let us recall that this figure <u>only appears</u> to assign 16% more energy than the actual rest mass of the proton. Let's remember that it only represents the total energy that a hypothetical particle having the actual magnetically drifted magnetic moment of the proton would have if it was moving in straight line.

In physical reality, this only implies that while the magnetic energy of the components of the proton is increased by 16%, its related electric energy is diminished by the same amount, which leaves the proton with the same well known energy associated with its rest mass. But for calculation purposes, it simply is convenient to work with the increased total energy since only half of this energy is considered in all pertaining calculation and that this half exactly corresponds to the real magnetically drifted energy of the proton.

Now from this figure and the known measured magnetic moment of the proton ($\boldsymbol{\mu_p}$ = 1.410606633E-26 J/T) we can calculate the actual magnetic field of the proton:

$$B_p = \frac{E}{2\mu_p} = \frac{1.74443114E - 10}{2 \times 1.410606633E - 26} = 6.183265764E15\,T \tag{25}$$

which in turn allows calculating the corresponding mean magnetic energy density of the proton

$$U_p = \frac{{B_p}^2}{2\mu_0} = \frac{(6.183265764E15)^2}{2\mu_0} = 1.521233803\,E37\ \ J/m^3 \tag{26}$$

Of course, this figure is a first level approximation of the proton energy density, which by definition can only be an average of the actual individual densities of the 6 proton components (3 quarks plus 3 carrier-photons). Research is ongoing to identify criteria that would allow more precisely pinpointing their actual densities.

The reader can further analyze the data provided, or even personally repeat this rather easy to reproduce experiment with magnets, which would allow obtaining more data points, graphing the curve and matching it to ideal inverse cube and inverse square curves, calculate best-fit exponent, etc.. It is important however to use flat circular donut-shaped loudspeaker type magnets, for reasons that must be obvious at this point. Presently, this is a novel and interesting experiment that appears in no textbook and that can be rather easily carried out in any high school physics lab.

Conclusion

This experiment conclusively demonstrates that interaction between magnetostatic fields for which both poles geometrically coincide obeys the inverse cube law of attraction and repulsion with distance.

By similarity, it also proves that localized electromagnetic elementary particles, that behave as if they were point-like by definition must obey the same interaction law since both of their own magnetic poles can only coincide with each other by structure.

Also, as a corollary, and contrary to electric dipoles whose opposite sign charges can be separated in space and observed separately, this experiment reveals that both aspects of point-like magnetic dipoles can be separated only in time, which characteristic highlights the fact that point-like elementary electromagnetic particles can magnetically interact only as if they were physical magnetic monopoles and that they are in fact, at any given instant, true magnetic monopoles.

We have shown that the related cyclic polarity reversal of the magnetic aspect of elementary electromagnetic particles such as electrons, quarks up and quarks down and of their carrying energy brings an explanation to the reason why electrons do not crash on their own onto nuclei despite electrostatic attraction by explaining why that magnetic interaction between nuclei and electronic escort can only be repulsive.

Obviously, magnetostatic fields that come close to one another tend to then move on their own towards or away from each other depending on whether they both are in relative anti-parallel or in parallel orientation. If we prevent this motion from taking place, as when we maintain by force the two magnets of this experiment at 5 cm from each other for example, this tendency to start moving manifests itself under the guise of a resistance to our action, a "pressure" that remains constant if we maintain the distance, and which is in fact a measure of the intensity of the force of attraction or repulsion at that distance.

The force of attraction and repulsion that we associate with magnetostatic fields seems stable and inexhaustible. If the material the field is anchored in isn't modified in its configuration, that force will not decrease in intensity with time and will always induce the same quantity of energy of motion in other magnetostatic fields that will approach at the same distance.

We could then be led to think that, while a magnet is being maintained at a fixed distance from another magnet, in such a way that the motion induced between them could not be expressed, if the level of this quantity of energy of motion was decreased somehow, by radiation under the form of free kinetic energy (photons) for example or rotation (Second Law of Thermodynamics), while the distance is maintained, that the quantity of energy of motion which corresponds to this distance would be instantaneously renewed and maintained between the fields.

The quantity of energy of motion that is induced by the magnetostatic field seems to be cumulative. It is this state of fact which produces the phenomenon of acceleration if the magnets involved are not forcibly maintained at a fixed distance. The phenomenon is much more difficult to observe when there is repulsion, because, given that the two magnets will immediately move further apart from each other, and that the quantity of energy of motion induced at any given distance during the motion decreasing as a function of the inverse cube of the distance, the velocity ultimately acquired will tend to quickly stabilize since the action of the field will rapidly become infinitesimal, much more rapidly than if the inverse square law of gravitation was involved.

On the other hand, when magnets are positioned so that there is attraction, the velocity will increase at a stunning rate for the same reason, meaning that at each point of the motion, the quantity of energy of motion induced will increase as the inverse function of the cube of the decreasing distance

The violence of the collision is due to the fact that the quantity of energy of motion induced at each distance is cumulative. The quantity of energy of motion that has been accumulated at the moment of contact will have become much higher than the level allowed, so to speak, at contact distance, which is why the totality of the excess quantity of energy of motion accumulated since the beginning of the acceleration in excess of the energy induced at contact distance be converted to kinetic energy at the instant of contact. The pressure that can be measured afterwards between the magnets at contact distance can in no way exceed or be less than that allowed by the energy of motion that can be induced at the precise distance of contact. The freed excess kinetic energy that will not immediately escape from the material as photons, will progressively diffuse as thermal energy in the bodies that have come in contact.

References

[1] André Michaud. **Theory of Discrete Attractors**, Canada, SRP Books, 1999.

[2] André Michaud. **On an Expanded Maxwellian Geometry of Space.** At: http://www.wbabin.net/physics/michaud.htm **or** Klyushin Jar.G., Smirnov A.P., **Proceedings of Congress-2000 – Fundamental Problems of Natural Sciences and Engineering**, Volume 1, St.Petersburg, Russia 2000, pages 291 to 310.

[3] Peter W. Atkins & R.S. Friedman. **Molecular Quantum Mechanics**, Third Edition, Oxford University Press, 1997

[4] David R. Lide, Editor-in-chief. **CRC Handbook of Chemistry and Physics**. 84th Edition 2003-2004, CRC Press, New York. 2003.

[5] Louis de Broglie. **La physique nouvelle et les quanta**, Flammarion, France 1937, Second Edition 1993, with new 1973 preface by L. de Broglie

[6] André Michaud. **Expanded Maxwellian Geometry of Space**. 4th Edition 2005, SRP Books.

[7] André Michaud. **Field Equations for Localized Individual Photons and Relativistic Field Equations for Localized Moving Massive Particles**, The General Science Journal 2006. http://www.wbabin.net/science/michaud.pdf

[8] Paul Marmet. **Fundamental Nature of Relativistic Mass and Magnetic Fields**, International IFNA-ANS Journal, No. 3 (19), Vol. 9, 2003, Kazan University, Kazan, Russia. (Also available from the Internet site http://www.newtonphysics.on.ca/magnetic/mass.html

[9] Stanley Humphries, Jr.. **Principles of Charged Particle Acceleration**, John Wiley & Sons, 1986.

[10] André Michaud. **Unifying all Classical Force Equations**, The General Science Journal 2006. http://www.wbabin.net/science/michaud1.pdf

[11] Robert Resnick & David Halliday. **Physics**. John Wyley & Sons, New York, 1967.

[12] L.D. Landau, E.M. Lifshitz and L.P. Pitaevskii. **Electrodynamics of Continuous Media**, 2nd Edition, Buterworth-Heinemann. (Л.Д. Ландау и Е. М. Лифшиц. **Электродинамика сплошных сред.** Издание третье, Москва, Физматлит, 2001)

[13] André Michaud. **On the Einstein-de Haas and Barnett Effects**, The General Science Journal 2007. http://www.wbabin.net/science/michaud3.pdf

[14] André Michaud. **Unraveling the Mystery of the Electron Magnetic Moment anomaly**, The General Science Journal 2007. http://www.wbabin.net/science/michaud4.pdf

[15] I.Estermann, O.C. Simpson and O. Stern. **The Magnetic Moment of the Proton**. Phys. Rev. 52, 535-545 (1937).