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A NEW HYPOTHESIS TO FULLY JUSTIFY THE GENERATION, MAINTENANCE, AND BEHAVIOR OF GEOMAGNETISM

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Abstract: The most scientifically accepted theory to justify geomagnetism was presented on November 15, 1919, by Joseph Larmor – that of the geodynamo, which would also justify solar magnetism. But this theory, under no circumstances, justifies all the geomagnetic behaviors already verified experimentally: the generation of magnetism – ability to generate ordered magnetic fields; magnetic decay between axes of rotation and magnetic alignment; erratic decline – the lag angle between the axes is erratic; not antipodes – the poles are not diametrically opposed; reversals - hundreds of magnetic pole reversals have occurred over millions of years; excursion - magnetic axis was temporarily aligned with the equator. Anyway, the origins of geomagnetism, until today, are not sufficiently well explained. Of the various theories already presented over a century ago, none of them meets all the geomagnetic phenomena and behaviors observed over time. The present work will present a new hypothesis to completely justify the generation, maintenance and behavior of geomagnetism, and that will certainly serve to justify, in the same way, the magnetic field existing in other celestial bodies.

Keywords: geomagnetism; origin; theory; analysis; criticism; geodynamo.

The origins of geomagnetism, according to the theories suggested and presented so far, are far from being justified by means of mathematical simulations based on electromagnetism. In the same way, despite an exhaustive search, no scientific experiments capable of justifying the varied geomagnetic behaviors on all time scales, whether in units of seconds (s); of hours (h); of days (d); years (a); centuries (100 years); millennia (ka) or millions of years (Ma). The great difficulties found to prove the phenomenon experimentally are not in the means of generating the magnetic fields themselves,

but in the justification of all the innumerable behaviors of geomagnetism over time, including the proven inversions of polarities. The most scientifically accepted theory to date to justify the origin of geomagnetism is the geodynamo theory, which cannot explain reversals^[1].

The present work will present a new hypothesis to fully justify the generation, maintenance and behavior of geomagnetism, and which will certainly serve to justify, in the same way, the magnetic field existing in other celestial bodies, including the existing magnetism on the Moon.

A BRIEF SUMMARY OF WHAT HAS ALREADY BEEN SAID ABOUT

The idea of a geodynamo attributes the generation of the magnetic field to the existence of electrical currents in the liquid medium of the Earth's core ^{[1], [2], [3], [4]}. However, this hypothesis does not even meet the current laws of physics. In order to induce currents, according to Faraday's Law, it is necessary to have a time-varying magnetic field on an electrical conductor.

Unlike all other hypotheses already raised and almost accepted by the scientific community, the theory proposed here does not consider that the geomagnetic field is produced, or generated, by electric currents, but by electric charges in motion.

A NEW HYPOTHESIS TO FULLY JUSTIFY THE GENERATION

The simple rotational movement of the incandescent solid inner terrestrial core promotes the movement of electrically charged masses and, in this way, promotes effects similar to those of electric currents, generating the magnetic field, on Earth or any other celestial body. The geomagnetic field is not generated by electric currents, but by the movement of electrically charged masses.

There is a layer of ionized particles on the outer perimeter of the inner core, solid, caused by thermionic emission, at a temperature of approximately 5000 °C^[5].

SCIENTIFIC BASIS OF THE HYPOTHESIS

The inner core is understood as the central core, solid, and that it is incandescent^[5]. There are plenty of indications that the positioning of the north magnetic pole has gradually migrated and lodged at different angles from West to East, in longitudes comprising an angle of 90 degrees in the last hundred years

^[6] When publishing his geomagnetic map of 1701, E. Halley recorded his opinion about the origins of the geomagnetic field^{[7], [8], [9], [10], [11] [12]}.

Halley devoted much of his time to modeling and mapping the behavior of the Earth's magnetic field. His great ambition was to solve the age-old problem of longitude through a better understanding of the Earth's magnetic field.

In 1683, Halley produced the first of many papers on the Earth's magnetic field. In 1696, he argued that the Earth was made up of an outer layer and a separate inner core. Each would produce its own magnetic dipole. The movement of the inner core would be responsible for the observed behavior of terrestrial magnetism^{[11], [12]}. Although Halley's model was eventually proven wrong, his belief that the behavior of the planet's magnetic field had its origins deep in the Earth's core resonated with explanations that emerged in the 1950s. The core is molten and is in motion.

It has been found that over the past 100 years the speed of the Earth's core has gained an extra quarter of a turn relative to the planet as a whole^{[13], [14]}. Interestingly, this finding fits with the records given by NASA and Columbia University regarding the movement of the

North magnetic pole position^[6].

On the other hand, British studies answered the question about which direction the center of our Planet turns. The inner core, made up of massive iron, is super-rotated towards the East^[15].

But all this lacks fundamental mathematical confirmations in electromagnetism and experimental findings, not being, therefore, the hypothesis, yet confirmed nor discarded.

Table 1 shows whether or not the various hypotheses raised to justify geomagnetism were met.

Table 2 shows the summary survey of the criteria met by each of the hypotheses raised to justify the presence and behavior of the geomagnetic field.

GENERATION AND MAINTENANCE OF MAGNETIC FIELDS

The Laws of Physics are sufficiently established, disseminated and consolidated. Such Laws established a great dependence between magnetism and the movement of electric charges. The electron received, by convention, the name of having a negative electric charge. Emphasizing, magnetism is dependent on the movement of electrical charges, or the movement of electrons. Such an assertion does not require references and is well known. Electrons are present in all atoms of all elements of all existing matter in Nature. The electrons are in constant and eternal movement around the nuclei, therefore, they are constantly generating magnetic fields. The direction and direction of the magnetic fields thus generated depend on the orbital alignment of the electrons. In most elements the orbital alignment of the electrons has such a distribution that the resulting total magnetism in the material is zero, under equilibrium conditions, and stable.

However, in some elements, such as iron, the orbital alignment of electrons can

be changed easily by applying an external, stimulating magnetic field. Depending on the constitution of the material, as in steels, the orbital alignment of electrons can be permanently modified, although not in an absolutely stable way, since the stable condition is zero resultant magnetism. Thus, a steel bar can be permanently magnetized, at different levels, within the remanence range of the ferromagnetic alloy. Such magnetization can be, in addition to different levels, also in different directions, depending on the amplitude, direction and direction in which the magnetic stimulus is applied to the ferromagnetic object.

MOVEMENT OF ELECTRIC CHARGES OR ELECTRONS

As previously mentioned, the existence of magnetism is intrinsically linked to the movement of electrons. Such movement of electrons exists spontaneously around the nuclei of atoms, without thermal dissipation, regardless of orbital alignment. That is, a steel bar may or may not be permanently magnetized, under stable conditions, without any effect on body temperature. However, the movement of electrons in a material can occur in another way: by applying an external stimulus to the material, called electric voltage, or electromotive force.

In this case, the movement of electrons between different atoms will occur and this is called electric current. The electric current, therefore, constitutes the movement of electrons between different atoms and is associated with the dissipation of energy, the generation of heat. In all materials and elements, the movement of electrons between atoms can occur, or the existence of electric current, through the application of a stimulus, Ohm has already established. That is, all materials can conduct electric current, some with greater or lesser ease, generating greater

or lesser thermal dissipation, according to Joule. This phenomenon is called – electrical conductivity. Metals such as silver, copper, gold and aluminum are considered good electrical conductors at room temperature (20°C).

In this way, if electric current constitutes the movement of electrons, this will always be associated with the generation of magnetic fields, of intensity, direction and direction well related to the intensity, direction and direction of the electric current in a material.

But there is another way to move electrons – by moving the materials where the atoms and electrons are. However, this movement simultaneously takes all the atoms, with all their constitution, and not just the electrons and, thus, may not result in the generation of magnetic fields.

For example, in **Figure 1**, a positive and a negative electric charge move together. Each electric charge generates a similar magnetic field, but in opposite directions. The result is a null magnetic field ($B = 0$) for all cases, except for the last condition – the charge with smaller radius generates a larger magnetic field in the center of the rotating plane, $B > 0$. Reversing the direction of motion nothing changes in all cases, except the last one, in which the polarity of the resulting magnetic field is reversed – reversal, $B < 0$.

The direction and sense of the generated fields, in the cases illustrated in **Figure 1**, comply with the right hand rules for positive polarity charges and the left hand for negative polarity charges.

The generation of the magnetic field by charges or by ions in rotating motion, in the magnitude of the induction B at the center of the rotating plane, can be determined by equation Eq. 1.

$$B = \mu_0 \cdot \frac{I}{2 \cdot r^+} [T] \quad \text{Eq. 1}$$

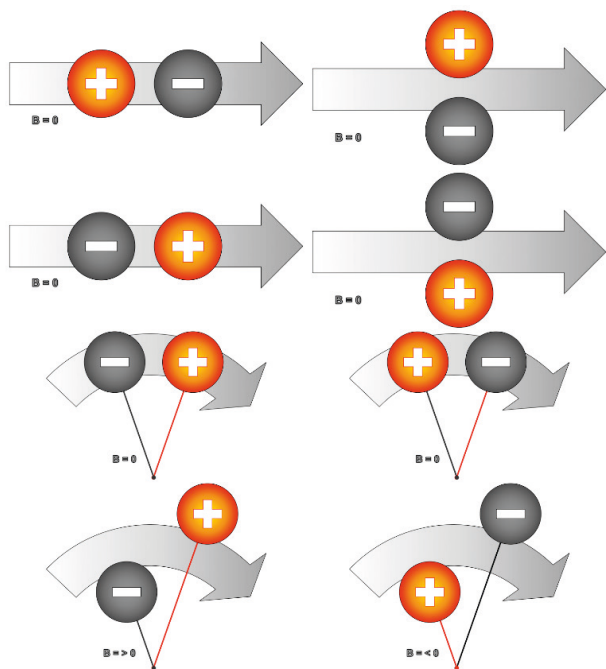
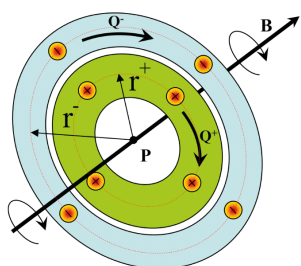


Figure 1 - MAGNETIC FIELD GENERATION - MODES

MATHEMATICAL SIMULATION BY ELECTROMAGNETISM

The generation of the magnetic field by charges or ions in rotating motion, when in different layers or different radii, with separation of positive and negative charges, as illustrated in **Figure 1** and **Figure 2**, occurs according to the derivation of the traditional electromagnetism equation. That is, the magnetic induction B at point P results according to Eq. 2.

$$B = \mu_0 \cdot \frac{Q \cdot \omega}{2} \cdot \left[\frac{1}{r^+} - \frac{1}{r^-} \right] [T] \quad \text{Eq. 2}$$



Where :
 $\mu_0 = 400 \cdot \pi$ [nH/m];
 Q = Electric charge [C];
 ω = Angular velocity = $2 \cdot \pi \cdot \text{rps}$ [1/s];
 r^+ = Orbit radius of positive charges [m];
 r^- = Orbit radius of negative charges [m]

Figure 2 - MOVEMENT OF ELECTRICAL CHARGES SEPARATED INTO LAYERS

As demonstrated, if the charges are separated, into positive and negative, in distinct rings, with distinct radii, a magnetic induction will result that is greater the greater the charge, the greater the rotation and the more distinct the radii. For equal radii, the resultant of $B = 0$.

In the same way as for a simple ring of charges, the magnetic effects are valid for a sphere of charges separated by thermionic effects. If this sphere, formed by infinite rings of charges, is rotating, a resulting magnetic field will occur inside it, in the direction of the field generated by the positive charges, whose radius is smaller. Mathematical simulation by well-founded theories of electromagnetism can confirm the magnetic generation capacity by the movement of electric charges in distinct radial orbits, as shown in the **Figure 4**.

SEPARATION OF POSITIVE CHARGES FROM NEGATIVE CHARGES

The issue of charge separation can be resolved and explained with the thermionic effect, already discovered by Thomas Edison in 1880 [16]. According to his discoveries, if a material is heated to incandescence, its electrons will receive such excitation that they move away from the material and can be ripped from their nuclei by electric fields. This is how the thermionic diode works, where a filament is heated to close to 3000 °C and an electric field between it and a plate, in a vacuum, promotes the unidirectional current. Hence, the rectifier was born, which transforms alternating current into direct current.

The maximum available current density on a metallic surface, in a thermionic cloud, according to Richardson-Dushman [17], can be calculated by Eq. 3 below.

$$I_s = A \cdot T^2 \cdot \text{Exp} \left[\frac{e \cdot \phi}{k \cdot T} \right] [A/m^2], \text{ where:}$$

A = Thermionic emission constant = 1200 kA/m² for pure metals;

T = Absolute temperature [K];

e = Charge of the electron = -160 · 10⁻²¹ [C];

φ = Metal work function [eV];

k = Boltzmann constant = 138 · 10⁻²⁵ [J / K].

Eq. 3

Two issues, however, remain to be clarified: how to separate the positive from the negative charges in rings or shells of different groupings and different radii and the direction of the magnetic flux, which resulted in the direction from Antarctica to the Arctic, contrary to what is currently verified.

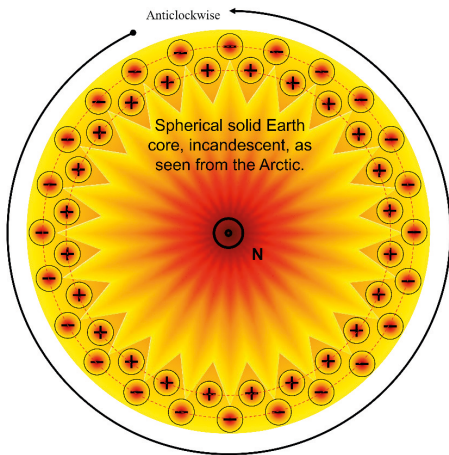
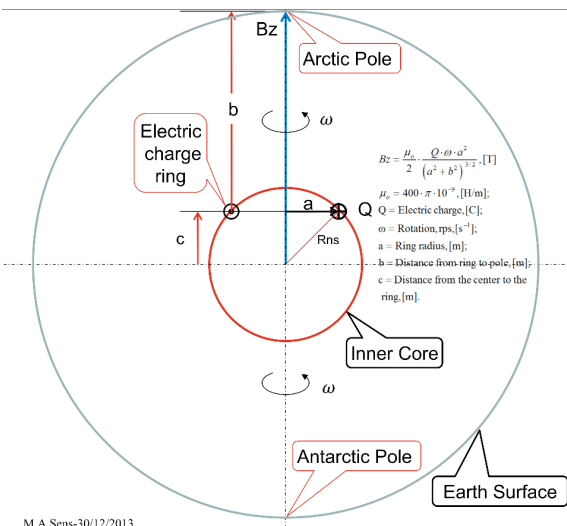


Figure 3 – EARTH SOLID CORE SEEN FROM THE ARCTIC



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Figure 4 – Mathematical Simulation TO Determine The Magnetic Field Generated By Rings Of Electric Charges

The result of these simulations, after integration along the inner core axis, is shown in Figure 5.

The temperature of the emitter material has a significant effect on the available current density, or the charge density on the surface, as shown in Table 1.

Thermionic Effect	Maximum Available Current Density (A/m ²)		
Work Function (eV)	4.50	4.81	4.50
Temperature (°C)	Iron	Graphite	Tungsten
1000	2.99E-06	0.177E-06	2.99E-06
2000	655	135	655
3000	1.52E+06	505E+03	1.52E+06
4000	108E+06	46.6E+06	108E+06
5000	1.67E+09	845E+06	1.67E+09

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Table 1 - THERMIONIC EFFECT - MAXIMUM CURRENT DENSITY

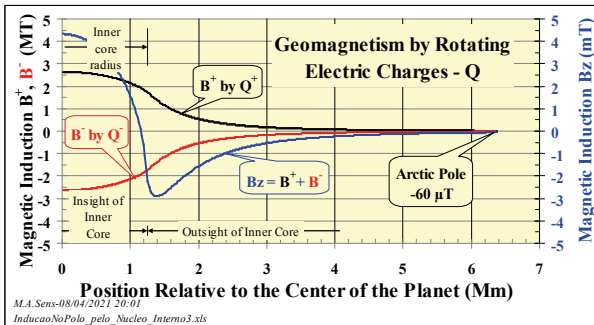
DIRECTION OF MAGNETIC FLOW

The issue of the direction of the magnetic flux generated by rotating electrical charges, distributed as shown in Figure 3, apparently inverted, can also be justified. As the solid core of the Planet rotates counterclockwise, currently, the direction of the magnetic field generated by the rotation of the positive ionic layer Q⁺ results upwards, by the right-hand rule, that is, from the Antarctic pole to the Arctic pole. On the other hand, the direction of the magnetic field caused by the rotation of the negative Q⁻ thermionic layer, external and also counterclockwise, results in the opposite. In magnitude, however, the B⁺ magnetic induction surpasses the B⁻ only inside the solid core. But outside the internal solid core, the opposite occurs, the induction generated by the negative charges Q⁻ exceeds the magnetic generation of the positive charges. As what matters is the resultant, the sum of the two magnetic fields, to obtain the resultant, B_z = B⁺ + B⁻ and, thus, the magnetic flux in the Arctic pole is negative, that is, it has direction towards the Antarctic pole, as illustrated in the mathematical simulation of Figure 5.

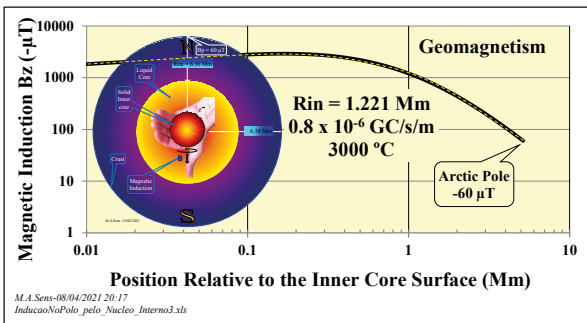
In this mathematical simulation, based on the Laws of Electromagnetism, without

any attenuation in the magnetic flux path, to result in a field of $60 \mu\text{T}$ at the Arctic pole, the magnetic induction inside the solid core resulted in approximately 4 mT , as shown in **Figure 5**, towards the Arctic. Outside the solid inner core, however, the magnetic field reverses, resulting in a drive toward the Antarctic pole.

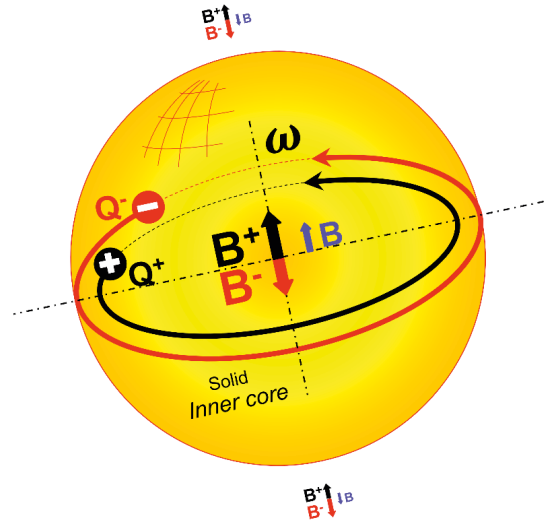
The complete mathematical simulations, conducted to prove the raised hypothesis, however, are beyond the scope of this work.



Separating only the magnetic field external to the solid core, generator, starting from its surface to the Arctic pole, without considering possible attenuating layers, the induction would be as shown in **Figure 6**, where the direction of the flow by the left-hand rule, for predominant negative charges, rotating counterclockwise.



An illustration of the solid inner core shows more clearly the direction of the resulting terrestrial magnetic field, both inside and outside the generating core, in the direction of the geographic poles, as shown in **Figure 7**. Note that in the figure, the magnetic field does not it is generated by electric currents, but by the movement of electric charges, positive and negative, in synchrony with the rotation of the incandescent solid core.



As shown in **Figure 5** and illustrated in **Figure 7**, the alignment of the geomagnetic field, generated by the movement of the internal solid core, results in perfect alignment with its axis of rotation. The sense of this magnetic field, however, results for the Arctic in the interior of the rotating core, where the field generated by the positive charges prevails. But outside the inner core, the field reverses and turns towards Antarctica, as the field generated by negative charges now prevails, or by the thermionically generated cloud of electrons, from an orbit with a larger radius. And this fact matches exactly what happens today. But it was not always so.

ABOUT INTERNAL SOLID CORE ROTATION SENSE

Planet Earth was formed together with most of the bodies of the Solar System, in a single instant, from a great explosion and such a hypothesis constitutes acceptance notoriety. From this explosion, the bodies received kinetic energy, in the form of an impulse, which implied rotation and translation movements, among other transitory oscillations. Due to the dimensions, the planets were molded in the shape approximately spherical, by gravitational action and the imposed rotation. Evidently, the rotational movements received by the celestial bodies were unidirectional for their entire mass, although asynchronously, as they were constituted, initially, by liquid and gaseous parts.

Altogether, there are at least fourteen distinct motions of Planet Earth, and likewise, its inner core oscillates asynchronously with respect to its shell. The geomagnetism thus formed, however, accompanies all these movements in an absolutely synchronous way with the incandescent solid core.

CAUSES, REASONS AND JUSTIFICATIONS FOR GEOMAGNETIC REVERSALS

There is no reason to consider the hypothesis that the cores of the planets had a direction and sense of rotation originally different from the main bodies, since the alignment of the axes of rotation constitutes the most stable form. That is, the Earth originally had unidirectional rotation for all mass, solid and liquid. Earth's solid, glowing core floats on a liquid core and rotates inertial and asynchronously with the planet. Such a core, solid and floating, has received impulses of kinetic energy from asteroids that collide with the Earth and grant them transient oscillations and even reversals in the axis of rotation, depending on the magnitude of the impact.

GEOMAGNETIC REVERSALS ARE ASSOCIATED WITH THE IMPACTS OF EXTRATERRESTRIAL BODIES

The impacts received by the planet Earth by the craters left on the surface are verified, which have already been cataloged in approximately 200 in the last 2000 Ma, with diameters of up to 160 km^[18]. It was verified, without an incessant search on the surface of the Planet Earth, that in 135 reversals, in the last 160 Ma, the normal polarity, like the current one, was present in 67 % of the time^[19] and that precisely in the periods of smaller frequency of impacts the polarity remained more stable, as shown in **Figure 8**.

The hypothesis that geomagnetic reversals are associated with the impacts of extraterrestrial bodies with Planet Earth is not new and was raised in 1996 by Müller^[20]. However, the justifications for the foundation of the hypothesis are fanciful and even hilarious. Explanations of how the geomagnetic field would have been neutralized by a large impact, then born again in opposite directions, in the “geodynamo” system, without a fixed remanent magnetic field on the Planet do not seem convincing.

The Earth rotates counterclockwise if viewed from the geographic North Pole, or Arctic Pole

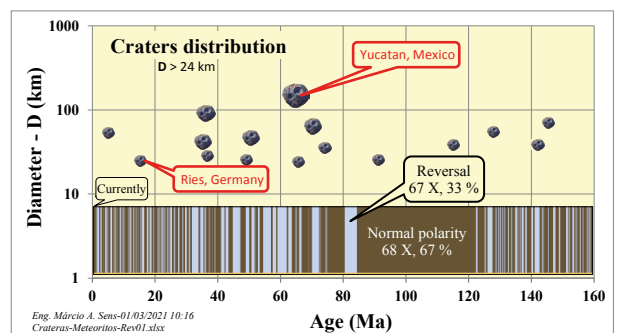


Figure 8 – Correlation of Geomagnetic Reversals with Asteroid Impacts

CONCLUSIONS

Geomagnetism certainly originated from the rotation of the Earth's inner solid incandescent core. This hypothesis can be mathematically confirmed by the Laws of Electromagnetism. In this way, the generation of the magnetic field occurs without the energy dissipation predicted in previous hypotheses, where the magnetic field would be generated by electric currents through the liquid core. In this case, there is no reaction or braking torque of the supposed geodynamo.

The Earth's solid inner core is floating in the liquid core, like the yolk floating in the white of an egg. However, the inner core of the Earth is not attached to the Planet, as in the case of the egg yolk, which is attached to the inner membrane of the shell through a cord called chalaza. An egg yolk, although it can rotate on its axis, cannot topple over and reverse poles relative to the shell. The inner core of the Earth, on the other hand, can topple over and invert its polar position, without stopping and without, in fact, reversing the direction of rotation with respect to its own axis.

The Earth's solid core can wobble in all directions and have the axis of rotation in alignment with the Earth's axis. Nothing prevents the Earth's solid core from being, for some time, off-center, displaced downwards, towards Antarctica, as it actually is today. Although such oscillations may have fundamental periods of millions of years, they are not infinite and the tendency, with damping, is that they cease over time and that the solid core remains in a condition of greater stability, that is, in alignment and in centralization with the axis of rotation of the Planet. As the magnetic field at the Antarctic pole is superior to that of the Arctic by 10 μT , the inner core, solid, must be outside the Earth's center, and be displaced towards Antarctica by approximately 320 km.

As it is detected, by superficial

measurements of almost 400 years, that the geomagnetic field has been falling over time [21], [22], [23], it is suggested that such behavior is due to two reasons – the decay of the rotation of the solid inner core and its temperature decay. This reduction is estimated at 41 % every 1000 years.

The marked drop in the geomagnetic field perceived at VSS-Vassouras – RJ - Brazil, of 40 % every 100 years [24], does not, in fact, constitute an image of the reduction of the magnetic field of the Planet, but of the place in particular. This reduction is a reflection of the inertial oscillation of the solid inner core. Or rather, such variation is due to the relative movement between the axes of rotation of the solid inner core and the Planet.

Why did the Moon's "dynamo" go out, causing the satellite to lose its magnetic field? The Moon currently does not have a magnetic field around it. Our natural satellite, however, already had a magnetic field billions of years ago [25]. Scientists believe it was once even stronger than Earth's current field. But how did this magnetic field work and why did it almost disappear? Good question [26]. The answer now seems simple: the Moon no longer has a solid, incandescent core rotating around its own axis, so it no longer constitutes a generator of magnetic fields.

The Moon, Venus and Mars currently do not exhibit significant magnetic fields. The Moon, because it does not contain an incandescent solid core. Venus, although it has an incandescent solid core, exhibits very low rotation, about 243 times less than the Earth, and, Mars, although it has an incandescent core, this one is not solid, but liquid [27].

Uranus axis of rotation is tilted more than ninety degrees with respect to the solar system's axis of revolution. In addition, the magnetic axis has a large inclination with respect to the axis of rotation. These effects combine not only to give Uranus a more

variable magnetosphere, but also suggest that the planet's magnetic field may be generated by a different mechanism than Earth, Jupiter and Saturn [28]. However, if it is considered that the magnetism is caused by the rotation of the solid incandescent core and that its axis is quite inclined in relation to the axis of rotation of the Planet, then everything is justified.

Furthermore, the current magnetic decline of Uranus is similar to what the Earth experienced, for a certain period, millions of years ago [29], that is, with the magnetic axis almost in the direction of the equator.

One of the great surprises of the Galileo mission was the discovery of a strong (750 nT) magnetic field at Ganymede, the largest and most massive moon of Jupiter [30]. The size of Ganymede inner core, is not well determined, however, its core size has been estimated to lie between 650-900 km [31].

The Sun, which is constituted in an incandescent sphere, with a diameter 100 times larger than the Earth and rotation 25 times smaller, approximately, constitutes, as a whole, a magnetic generator described here, exhibiting fields of the order of twice that found in the Earth.

The magnetic axis of inner core is currently

not aligned with the Earth's axis of rotation, but absolutely aligned and synchronous with the motions of the solid inner core.

The distribution of the magnetic field in the Earth's crust and surface, however, depends on the presence and distribution of magnetic minerals in the crust and upper mantle. Electric currents induced by the flow of conductive seawater through the ambient magnetic field contribute even more, albeit weakly, to the magnetic field observed at the surface of the Planet.

Any other theories about the origins of geomagnetism are just conjectures, without any foundations based on electromagnetism, very well described in Physics.

It follows, by extension, that the solid inner core is not currently concentric with planet Earth, if it were, the geomagnetic axis would be aligned with the Earth's rotational axis.

Experimental Confirmations

The Author searches for entities that can provide technical and logistical support for conducting experiments capable of validating the hypotheses formulated in this article. Proposals can be submitted via the E-mail provided at the top of this document.

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