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Inside Planets and Stars Masses

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Abstract:- It can be shown that the mass of nucleons varies with adiabatic pressure inside celestial bodies and that such adiabatic pressure on the electronic escorts of atoms in the centre of celestial bodies reaching stellar mass ignition threshold through accumulation of primordial hydrogen is the triggering cause of nuclear fusion at the centre of such bodies.

Keywords:- proton, electron, neutron, positron, Sun, critical velocity, supercritical velocity, adiabatic acceleration, corona engine, fusion reactor, second, meter, kilogram, kg, 3-spaces, nucleon dilation.

I. MATTER IN THE UNIVERSE

A. Stable elementary particles

It is well understood that all stable bodies in the universe, from the smallest meteorite to the largest star are made of normal matter, meaning that their mass is made up exclusively of combinations of all possible stable and unstable isotopes of all atoms that can naturally exist, all of which can be found in the familiar Periodic table of elements. All of these atoms are in turn made up exclusively of a very restricted subset of only three stable and charged scatterable fundamental elementary particles, which are the **electron**, the **up quark** and the **down quark**.

Careful study of the literature reveals that all quarks other than up and down are short-lived unstable partons, which means that none of them could ever be scattered against during non-destructive high energy electron-proton scattering. Unstable and virtual particles are discussed in the next section.

All 3 stable and scatterable particles are considered "elementary" because absolutely all non-destructive collision experiments ever carried out, even the most energetic up to, but short of, destructive scattering, reveal that they behave in all circumstances as point-like particles, which means that we have *de facto* formal proof that they do not have internal structures, which in turn confirms that they are not made up of smaller particles. They are considered stable because unless they are physically destroyed by destructive scattering, they have an unlimited life span.

Up and down quarks associate in groups of 3 to form nucleons (**protons** and **neutrons**), that is, 2 up quarks plus 1 down quark, which have been proven through high energy non-destructive scattering to make up the scatterable internal structure of a proton (uud), while 2 down quarks plus 1 up quark have been similarly proven to make up the scatterable internal structure of a neutron (udd). The various elements of the periodic table and all of their isotopes are made up of all possible stable and metastable combinations of these nucleons, while electrons settle on the various possible electronic layers that define the measurable volume of the various atoms.

When a photon is absorbed by an electron in an atom, this excess energy forces it to leave its rest orbital to move further away from the nucleus. If the amount of energy communicated to the electron is insufficient to cause it to completely escape the atom, it will momentarily stabilize on the furthest authorized orbital away from the nucleus that its newly acquired energy allows.

Any energy in excess of the precise amount required to meta-stabilize on this new orbital but insufficient to reach the next authorized level further away from the nucleus simply over-excites the electron on this new orbital, an over-excitement perceived as "heat" at our macroscopic level.

Photons are produced as such over-energized electrons lose this excess energy under the form of a photon as they fall back towards the nucleus until they ultimately reach the orbital closest to the nucleus that they can possibly reach, that is, the rest orbital, or "least action" orbital, for this electron in this atom. Photons can also be produced when nucleons in nuclei lose excess energy in a similar manner.

B. Unstable and virtual particles

Exploratory high energy scattering of fundamental particles can be carried out in two different ways, that is, non-destructive scattering and destructive scattering, and the absence of a clear description in textbooks of the difference between both types has been the cause of widespread confusion.

Non-destructive scattering was used for a short period in the 1960's to explore the only two stable composite particles in existence, which are the proton and the neutron already mentioned as being the only components of all existing atomic nuclei.

This process involves colliding neutrons and protons (nuclei of hydrogen and deuterium atoms captive in water molecules) with electrons or positrons having sufficient energy to enter the nucleon structure, but insufficient energy to knock the components making up their internal structure out of nucleons. This led to the

discovery at the SLAC facility in the 1960's, that the only scatterable inner components of both proton and neutron are the up and down quarks already mentioned.

Finding no other components inside nucleons, destructive scattering started being used towards the end of the 1960's, and has been used to higher and higher energy levels ever since. It involves physical destruction of massive elementary particles that occurs when two same sign particles directly scatter against each other with such energy that they both convert to free energy (photons) and thus cease to exist under their initial form, or when two opposite signs elementary particles combine and end up also converting to photons.

When the destructive level is reached during such scattering experiments, a huge amount of free energy is liberated as the incident bullet (an electron, for example) and the up or down quark that it directly scatters against are converted to energy. This total amount of energy liberated is made up of all of the kinetic energy of the incident electron carrier-photon ([26]), plus that of the carrier-photon of the quark being scattered against ([30]), plus the energy that made up the rest masses of the quark involved and of the incident electron.

Whenever such a huge amounts of free energy are released, they immediately congeal back into all sorts of transient metastable hyper-excited massive states that are generically named "**partons**". The larger the amount of energy liberated in any such occurrences, the more massive the initial transient particles created will be.

As part of the liberated energy, there may be cases when one of both of the particles involved could be ejected without being destroyed. Let us note that this barely diminishes the amount of free energy liberated since the energy making up the rest masses of both types of quarks and of the incident electron or positron are very small with respects to that of their respective carrier-photons at the moment of impact. What happens to the quark that is not destroyed when ejected during such occurrences is covered in a separate paper ([30], Section XIII).

Even the recently much hyped about **Higgs boson** belongs to this parton category, actually the most energetic parton yet detected as an up or down quark from an incident proton directly and destructively scattered against one of the up or down quarks of a target complex particle (another proton) at the **LHC** facility.

Four of the first partons that were long-lived enough to be detected in the 1970's were given the names **charm quark**, **strange quark**, **bottom quark** and **top quark**, because they seemed to satisfy the most popular theory of the time, even though, like all partons, they all almost immediately decay into the more stable particles set.

Unfortunately, all of these short-lived partons are useless as far as describing normal matter is concerned, because they can only be created outside the confines of protons and neutrons by means of this type of destructive scattering and can under no circumstance be identified within proton and neutron structures via non-destructive scattering.

This did not prevent the physics community from classifying these short-lived metastable massive states as being part of the Standard Model in a feverish and apparently endless search for more and more of these transient massive energy states, even though they obviously cannot be part of stable matter structures.

The same restriction also applies to the variety of "virtual" particles that have been defined, such as gluons and "virtual photons", which are mathematical concepts conjured up in attempts to satisfy the currently popular theories. A clear distinction must also be made between real photons, that are scatterable and can be deflected by gravity ([35]), and Quantum Electrodynamics "virtual photons" which are mathematical metaphors conceived of by Richard Feynman ([20], p.711) to more easily calculate interactions between fundamental particles.

However, the "virtual photons" metaphor unfortunately bundle together two fundamentally very different aspects of the relation between particles, that is the Coulomb force and the kinetic energy induced by this force, which, because of the similarity in name, induces a high level of confusion with "real photons" ([35]) that are made up of only kinetic energy. See reference ([6], Chapter 2) for a more complete analysis of this issue.

In nature, unstable partons also occur as fleeting massive states such as the various configurations of pi and K mesons, as well as hyperons, which are unstable complex particles still more massive than protons and neutrons, and a few elementary unstable particles such as muon and tau, with life expectancies never exceeding a few fractions of a second.

What is remarkable about all of these unstable particles that are created as fleeting by-products of cosmic radiation (mostly made up of high energy protons) colliding with celestial bodies (scattering against atomic nuclei making up the molecules of their atmospheres really, when they have an atmosphere), of high energy interactions in stars' coronas and in the permanently exploding star masses, is that without exception, the final end product of their practically instantaneous decay is always a stable particle or a combination of the only known stable massive particles, that is, protons, neutrons, electrons, and positrons, besides photons and neutrinos.

The positron, known to be the anti-particle of the electron, is identical to the electron except for the sign of its charge ([25]), but does not become part of stable atoms as the electron does because it readily reverts to various photon states as soon as it individually interacts with an electron, destroying the electron in the process. This process is named positronium decay ([30], Section B).

The 3-spaces model reveals however that when the right circumstances are met, positrons may well be instrumental in the construction of nucleons ([30]), and thus be essential to the star ignition process as well as to star activity maintenance as we will soon see.

Neutrons on their part, although having a mean half-life of about 16.88 minutes when isolated, tend to become permanently stable when they become part of atomic nuclei, but when they decay, they leave behind two totally stable particles, that is, a proton and an electron plus neutrinos ([34]).

All unstable and ephemeral complex particles could be considered simply as hyper-energetic states of the fundamental stable particles set that they ultimately convert to since all of them eventually revert to these least energy states after having evacuated all of their excess energy. Any further discovery of more unstable ephemeral partons yet more energetic could only confirm this observation.

Muons (second generation partons since they come from meson decay ([11], Section I), which are first generation partons) and tau particles (first generation partons produced by destructive head-on electron-positron scattering, first observed at the SLAC facility in the 1970's) always leave behind a single electron as a solitary massive by-product of their decay, besides possibly a few gamma photons and neutrinos. In a certain way, both muon and tau can be considered as simple unstable hyper-massive states of electrons that decay by neutrino emissions. The mechanics of electronic, muonic and tauic neutrino emissions are analyzed in a separate paper ([34]).

II. THE INTERNAL STRUCTURE OF NUCLEONS

As soon as protons and then neutrons were experimentally detected in the 1920's and 30's, there was a suspicion that they may not be elementary, contrary to electrons.

The first non-destructive high energy scattering experiments in the 1940's and 50's confirmed that they occupied very small but definitely not point-like volumes in space, contrary to electrons, that behave point-like even when subjected to the highest possible energy non-destructive collision experiments.

The first high energy accelerator powerful enough to cause the scattering bullets (high energy electrons) to actually enter the inner structure of the target protons and neutrons was the Stanford Linear Accelerator (SLAC) that entered active service in 1966.

As already mentioned, experiments carried out from 1966 to 1968 at this facility with high energy non-destructive scattering of electrons against the inner components of nucleons allowed identifying three elementary massive particles inside each target nucleon, 2 up quarks having a charge equal to 2/3 of that of a positron, and 1 down quark having a charge equal to 1/3 of that of an electron inside protons, and 1 up quark and 2 down quarks inside neutrons, identical to those making up the proton.

These same experiments also revealed that these physically scatterable particles, systematically behaving point-like just like electrons, are moving locally at highly relativistic velocities on closed orbits and that it is their captive translational motion that determines the actual volume occupied by nucleons in space.

An important energy loss as some electrons directly backscattered against these quarks revealed also that they are only marginally more massive than electrons. The masses of up and down quarks as revealed by these highly inelastic collisions ([19]) are very low compared to the total mass of nucleons (See **Table III** further on). They implicitly reveal that the greater part of the rest mass of protons and neutrons can only be relativistic in nature and can only be due to the highly relativistic velocities of the up and down quarks locally captive at near light velocity on closed orbits.

We had finally reached the most fundamental level of the building blocks of the universe, and no other scatterable particles was ever discovered afterwards inside nucleons, which are the only components of all atomic nuclei in existence.

III. UP AND DOWN QUARKS FRACTIONAL CHARGES

The fact that the fractional charges of up and down quarks could be individually measured from the rebound patterns of the non-destructive electron "bullets" during the SLAC experiments confirms that they always remain at some distance from each other within the nucleon structures, a distance that can obviously be related to the radius of the volume occupied by nucleons.

Since charges, be they fractional, cannot be dissociated from electrostatic attraction and repulsion, particularly intense at such close range (the radius of nucleons is known to be in the 1.2E-15 m range), whatever other forces may be at play inside nucleons, it is a given that these charges do play a role in defining the actual equilibrium distances that they maintain as they locally translate and rotate without ever coming close enough to cause the nucleon to appear point-like during any type of scattering.

The 3-spaces model reveals that it is quite possible that nucleons could come into being as triads of electrons and positrons mutually capture in certain conditions to then adiabatically accelerate until they reach these hyper-accelerated equilibrium states that protons and neutrons seem to be.

Indeed, if down quarks actually are electrons being constrained into showing up as down quarks with fractional charges when confined into the structure of a nucleon, they fundamentally remain the same elementary particles, but in a slightly more massive form and with diminished electric field and increased magnetic field caused by energy drift towards magnetic state, a drift itself due to the very tight closed orbit that they are then constrained into. The same would of course apply to up quarks being similarly constrained positrons.

Then of course, the fact that up and down quarks could never be observed moving freely out of destructively scattered nucleon finds a quite simple explanation in the 3-spaces model, because as soon as they are liberated from the constraining electromagnetic environment of the nucleon structure during destructive scattering events, the down quarks (constrained electrons) and up quarks (constrained positrons) involved would immediately recover their fully unrestricted unit charge and usual rest mass.

Positrons being the anti-particles of electrons, they are viewed as "anti-matter" with respect to electrons, which are viewed as "normal" matter. There is a century old assumption that the universe is made almost entirely of "normal" matter (which also includes protons and neutrons), and endless speculation as to why so little "anti-matter" is to be found, which is deemed to directly contradict the principle of symmetry.

This issue is completely resolved in the 3-spaces model since down quarks and electrons, on one hand, turn out to be the same particle with negative charge (normal matter), can only exist in exactly the same number as up quarks and positrons, on the other hand, that turn out to be the same particle with positive charge (anti-matter), thus completely satisfying the principle of symmetry since all existing matter is made up exclusively of these particles.

The detailed description of the mechanics of nucleon genesis (nucleogenesis) by adiabatic acceleration of electrons and positrons in the 3-spaces model far exceeds the scope of this paper, but is fully exposed in a separate paper with complete theoretical support ([34]). Similarly, the magnetic drift responsible for the diminished electric charges of elementary particles forced into closed orbits is analyzed in another paper ([8]).

IV. ELECTROSTATIC FORCE INTERACTION BETWEEN CHARGED PARTICLES

C. The Standard Model

The physics community has categorized all possible cases of fundamental force interaction as four forces: 1) **Strong force**, 2) **Weak force**, 3) **Electromagnetic force**, and finally 4) **gravitation**; a restricted set that it has been working ever since at relating to a single ultimate fundamental force that would cause them all.

D. The special case of the electromagnetic force

A note of interest in this regard is that in the Standard Model, **the electromagnetic force** is universally defined as the force acting between electrically charged moving particles!

So by very definition, since the Standard Model considers that the electromagnetic force is made up of the electrostatic force acting between charged particles at rest, and the combined effect of electric and magnetic forces acting between charged particles moving relative to each other, it mandatorily also is a component of the **strong force** acting between up and down quarks inside nucleons since they are electrically charged and moving, so that up and down quarks thus belong by definition to the select group of particles between which the electromagnetic force is known to be in action. Specific calculations ([7]) even show that the electromagnetic force may even be sufficient to explain all characteristics of nucleons.

Consequently, without even violating the definitions of the Standard Model, it can be asserted that a large component of the forces in action between up and down quarks inside nucleons involves some sort of local electromagnetic equilibrium made up of the combined effect of electric and magnetic attractive and repulsive forces acting between the charged quarks, involving a level of magnetic energy in proportion with the local highly relativistic velocities of the quarks, a magnetic energy further enhanced to the expense of the quarks electric charge energy due to the so tight gyroradii of their circular motion on the closed orbits that they are captive on ([7] and [8]).

On the other hand, it is well understood that electrostatic attraction (and repulsion) between charges has an infinite range.

E. Electrostatic repulsion between like sign particles

Before going further, let us clarify a little documented aspect of electrostatic repulsion between same sign particles. It is well understood that repulsive electrostatic force between same sign particles has an infinite range, just like electrostatic attraction between opposite signs particles. And there is an intuitive assumption that electrostatic repulsion can have an important effect at large distances just like electrostatic attraction.

Such large effects are definitely measurable at distances such as between both up quarks in a proton or both down quarks in a neutron, and even at distances such as between nuclei and electronic escorts in atoms.

But the fact is that since electrostatic repulsion decreases in intensity as a function of the inverse square of the increasing distance between any pair of like sign particles, its effect quickly becomes infinitesimal as the distance increases between any pair of these particles; to the point of becoming barely detectable, if at all, even at millimeter range distances between a single pair of opposite sign elementary particles.

It is well known that large numbers of atoms and molecules need to be ionized at our scale for this repulsion to become measurable with lab instruments. The largest concentrations of like sign ionized atoms and molecules known to us naturally occur only momentarily in gaseous media such as the Earth's atmosphere, and they quickly dissipate, sometimes brutally through lightning, but more often by simply dissipating due to the very repulsion between these like sign ions which permanently tend by nature to move as far away from each other as they can, until they eventually end up neutral as weakly bound electrons in the surrounding environment are captured by the positive ions.

Consequently, electrostatic repulsion is an important factor at elementary particles close quarters range, a barely noticeable factor at our range except when momentary huge concentrations of ions occur and an absolutely insignificant factor at astronomical range.

The best proof of the insignificance of electrostatic repulsion at our macroscopic level can be verified by anybody just considering that all atoms making up all molecules in all bodies about us including our own bodies systematically present to the outside world their mutually repelling electronic escorts.

This does not prevent us from getting close to these bodies without feeling any repulsion whatsoever until "touching" contact is established. In fact, this "touching" contact that prevents interpenetration is the most

intense manifestation of the electrostatic repulsion between like charged electronic escorts that can be perceived at our level and it is easily verifiable that it occurs at submicroscopic distances, even with the massive amounts of electronic escorts that are involved in such "touching" encounters.

F. Electrostatic attraction between opposite signs particles

Electrostatic attraction between opposite sign particles on the other hand grows in intensity as a function of the inverse square of the decreasing distance between any pair of like signs particles, so contrary to electrostatic repulsion, it builds up in intensity as distance diminishes between a pair of opposite sign particles. This means that two opposite sign particles, even located at an astronomical distance from each other, will constantly seek to close in on each other until they eventually succeed in reaching the closest (rest) distance from each other that the local electromagnetic equilibrium will allow.

A separate paper ([9]) demonstrates the actual identity between all classical force equations, from atomic level to astronomical level and reveals that the electrostatic force is involved in all force equations, including that of gravity. So let's re-examine from the most intense range (inside nucleons) to the less intense range (at the intergalactic level), the various orders of magnitude of electrostatic force application.

V. THE FOUR RANGES OF ELECTROSTATIC ATTRACTIVE FORCE APPLICATION

To more easily create a mental picture of the various orders of magnitude of application of the electrostatic force between opposite sign particles, let's make use of the idea that an individual inverse-square-of-distance-attractor would be at play between each pair of opposite sign particles in the universe. For simplicity's sake, we will name "**attractor**" any occurrence of electrostatic attraction between any pair of opposite signs charged particles in the universe.

G. Primary order electrostatic attractors

To get a feel of the strength of the electrostatic attraction between each up quarks in a proton and the single down quark, let's calculate the approximate force involved, roughly estimating the distance between them at about 2 E-15m inside a nucleon. Such calculation is easily carried out with the standard values of electrostatic constant **k** = 8.987551788 E9 m/F (meters per Farad), and that of the unit charge **e** = 1.602176462 E-19 Coulomb, in the Coulomb equation (1).

$$F = k\frac{\left(\frac{2}{3}e\right)\left(\frac{1}{3}e\right)}{(2\,E\text{-}15)^2} = 12.817 \text{ Newtons} \qquad (1)$$

So we observe that inside nucleons, an ambient electrostatic attractive force is at play between each up quark and the down quark of the order of 13 Newtons, which is generally considered a manifestation of **the strong force** in the Standard Model, that is, a force 156 million times more intense than those keeping the electron captive on the rest orbital of the hydrogen atom! For the needs of the current analysis, we will name each occurrence of attraction between an up quark and a down quark inside a nucleon a **Primary order attractor**.

A similar calculation for the attraction inside neutrons is of the same order of magnitude since the estimated radius of the neutron is of the same order as for the proton.

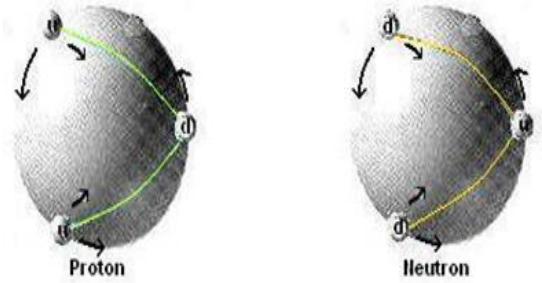

Fig.1: Primary order electrostatic attractors

Considering the drawings proposed in **Fig.1** to summarily symbolize the quarks in motion for both proton and neutron as a means to help visualizing the nucleons structure, we can easily relate to the idea that the quarks in each nucleon have to be locally translating and rotating as a rigid triangular formations at distances from each other at least partly determined by the interplay of their inertia and the strength of the attractive and repulsive electromagnetic forces imposed by the proximity of their charges at the highly relativistic velocities that define the volume (represented by the sphere) occupied in space by each nucleon.

Not all factors determining the actual radius of nucleons have been understood yet, but electrostatic attraction between opposite sign charges, be they fractional, constantly pulling opposite sign particles towards each other, and the inertia of these massive charged particles constantly fighting to force them to move in as straight a line as possible against the acting transverse forces are very well understood in all of their aspects.

The other factor at play in maintaining the stability of the nucleons structures, that is, the magnetic repulsion between the nucleon components is analyzed in a separate paper ([7]).

H. Secondary order electrostatic attractors

Let's now consider the electrostatic attraction between nucleons making up the nuclei of more complex atoms, which is also considered a manifestation of the **strong force** in the Standard Model, but that we will describe as a secondary order attractor since their most intense manifestations are distinctly weaker than the primary attractors already described. Let us examine for that purpose the simplest complex atom there is, which is the deuterium atom (**Fig.2**).

In real deuterium atoms, both nucleons will of course be much closer to each other than any 2-dimensional representation can show and will mandatorily organize at each instant into the tightest possible best fit dynamic attractors configuration allowed by the fact that the quarks of each nucleon constantly maintain the highly relativistic local translation velocities that determine their masses and volumes, which in turn can only prevent them from interpenetrating.

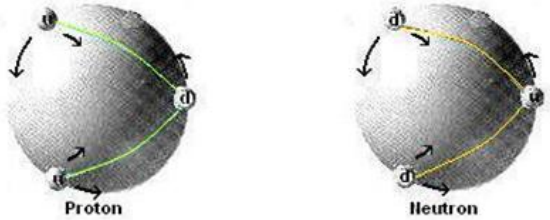

Fig.2: Secondary order electrostatic attractors

Examining now **Fig.2** representing the inner structure of a proton and a neutron in this symbolic representation of the deuterium nucleus, we can observe that 5 attractors are required to link the proton to the neutron; that is, two attractors linking each down quark of the neutron to the two up quarks of the proton, for a sub-total of 4, and one more attractor to link the single down quark of the proton to the single up quark of the neutron, which makes for a total of 5 attractors required to link up all opposite sign charged particles of the deuterium nucleus, and that we will name **Secondary order attractors**.

Considering that both triads of the deuterium nucleus are very close to one another but with no possibility to interpenetrate due to the highly relativistic velocities that keep maintaining the mass and volume occupied by each nucleon in space, it is unavoidable that these 5 secondary order attractors will be less powerful than the primary order attractors that hold the quarks together in the internal confines of each triads.

Considering that the quarks are permanently in motion inside each nucleon, it can logically be assumed that the closest mean distance between each quark in a nucleon and quarks of the other nucleon in closest possible proximity as is the case in the nucleus of a deuterium atom, would be of the order of a little more than twice the radius of a nucleon, that is about 2.5E-15 m

So using again the Coulomb equation with this larger distance, we obtain:

$$F = k\frac{\left(\frac{2}{3}e\right)\left(\frac{1}{3}e\right)}{\left(2.5\ E\text{-}15\right)^2} = 8.203\ N \qquad (2)$$

Which reveals that the strongest possible secondary order attractors will be 1/3 less powerful than primary order attractors but still 100 million times more intense than those keeping the electron captive on the rest orbital of the hydrogen atom!

In more complex nuclei where nucleons have no choice but to distribute in layered best fit close packing, a number of them will not be in immediate contact with some other nucleons of the same nucleus, being separated by other nucleons and whatever intervening space that the local rest state electromagnetic equilibrium mandates, which will reduce the strength of the secondary attractors force between these constituting nucleons.

For simplicity's sake, we obviously ignore here the other factors (magnetic or any other influences that determine the local rest state electromagnetic equilibrium) that also contribute in defining the actual distances between nucleons in complex atomic nuclei ([7]).

Back to the deuterium atom, wouldn't it be logical also that the strength of the 5 secondary order attractors, each one pulling outwards the quarks of the neighboring nucleon, would succeed in forcing those quarks to expand somewhat their local translation orbits, thus forcing a lessening of their velocity, which in turn would diminish in proportion their relativistic mass contribution?

Couldn't this also go a long way to explain at least in part why deuterium nuclei are slightly less massive than the sum of the effective masses of a proton and a neutron measured separately? Couldn't this very simple process also explain in great part why all complex nuclei are less massive than the sum of the effective masses of the individual isolated protons and neutrons that make them up?

I. Third order electrostatic attractors

Let us now examine the next order of electrostatic attractors, responsible for the interaction between electronic escorts and nuclei in all atoms, which is generally considered a traditional manifestation of the **electromagnetic force** in the Standard Model, and that we will name **Third order attractors**.

Let us consider an electron on its mean rest orbital about a proton (**Fig.3**) in an isolated hydrogen atom (averaged out to the Bohr radius). Given that two of the proton's quarks have a positive charge, two third order attractors will exist between the negative electron and these two quarks.

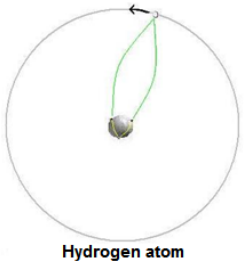

Fig.3: Third order electrostatic attractors

Note that at such a distance, the repulsive force between the proton's down quark and the electron is still a factor, and due to the relative distance between electron and proton, the three quarks of the nucleus actually behave point-like as considered from the electron location.

To get a feel of the relative size of the proton from the electron's perspective, if we imagine the proton being the size of the Sun, then the mean electron orbit, which corresponds to the actual volume that the hydrogen atom occupies in space, would average out at a distance 30 times further away than the Earth orbit, that is, as far as Neptune! So as seen from Neptune, the Sun would appear practically point-like, with no visually measurable diameter, just the brightest star in the Universe. For all practical purposes, such an atom would be as large as the entire Solar system!

So let us calculate the force involved at the 5.291772083E-11 m Bohr Radius distance as if the proton was point-like with a unit charge ($2x\ (2/3)^{+} + (1/3)^{-} = 1^{+}$):

$$F = k\frac{e^2}{r^2} = 8.2\ E-8\ N \tag{3}$$

We observe here an intensity of the attractive force that is almost 156 million times weaker than the forces at play between an up quark and the down quark inside the proton!

In heavier atoms, like uranium for example, the innermost electronic layers lie closer to the nucleus than in the hydrogen atom so electrons occupying these layers are attracted still more strongly towards the nucleus by an obviously larger number of tertiary order attractors pulling on each electron, but these stronger attractors are still of the same order of magnitude.

Let us note by the way that the attractors linking the up and down quarks of an atomic nucleus to the electrons of its electronic escort and to nuclei and electronic escorts of other nearby atoms associated in molecules and even in local masses as large as planet size and even star size, while being weaker than for those reaching the Bohr radius reference previously established by possibly up to a few orders of magnitude, also belong to the tertiary order attractor category because they belong to the same local matter accumulation.

Table I: Summary Table of Local Attractors

Table of local attractors		
Name	**Range**	**Related "Traditional" Force**
Primary attractor	Between heterostatic quarks inside a proton or neutron	Strong
Secondary attractor	Between heterostatic quarks belonging to different protons and neutrons in a nucleus	Weak
Tertiary attractor	Between an orbiting electron and each of the Up quarks of the nucleus	Electromagnetic
Temporary local attractor	Between half-photons inside a photon	Electromagnetic

Complete description of the first 3 attractors mentioned in **Table I** is available in Chapter "**23 The Force of Gravity**" of reference ([6]), including that of temporary local attractors, whose analysis is out of context in this paper.

J. Fourth order electrostatic attractors

Finally, **Quaternary order attractors** are those in action between each particle of any size local accumulation of matter (from single isolated electron, neutron or ionized proton to superstar size masses) and each heterostatic particle in the rest of the Universe, currently identified as the **force of gravity** of the Standard Model

The analysis carried out in paper "**Unifying all Classical Force Equations**" ([9]) effectively demonstrates that the electrostatic force acting to infinity between all particles of opposite signs (just identified as quaternary order attractors in this paper) is the only possible electromagnetic candidate for supporting gravitational interaction.

Of course, it is at this point that the traditional objection is aired, that since the electrostatic force can be attractive or repulsive depending on whether the two particles concerned attract or repel each other, while the force of gravity can be only attractive between all particles, which supposedly disqualifies the electrostatic force as a plausible candidate for the force of gravity status.

It must be clearly understood here that the electrostatic force *per se* does not attract nor repel **but induces unidirectional energy** in the particles subjected to the force; that the resulting relative direction of motion of these particles depends on whether they are attracting or repelling each other; and that **it is not the force itself** that causes them to move away from or towards each other at the corresponding velocity **but the accumulated directed energy induced by the force**.

All particles, atoms or larger masses that are not in rest equilibrium with respect to other particles, atoms or larger masses are inevitably in free fall with respect to these other objects, and as such are subject to an acceleration due to the combined action of all quaternary order attractors that connect each particles making up these free falling objects to all other heterostatic particles in the universe.

In context, the term heterostatic refers to two particles having opposite sign charges while homostatic refers to two particles having same sign charges.

Over the course of the billions of years that went by since the beginning of times, atoms have collided with some of them ending up remaining captive of each other, because the increased intensity of the quaternary order attractors associating them over short distances eventually prevented them from escaping to continue on their individual free fall travel. These quaternary order attractors thus de facto attain the order of magnitude of tertiary order attractors and henceforth belong to that category.

Each accumulation of atoms thus formed is also free falling with respect to all bodies with which it is not in immediate contact, and is subject to the acceleration induced by the whole collection of quaternary order attractors that connect each of the particles making it up, to all other heterostatic particles in the rest of the universe.

The order of magnitude of quaternary order attractors then logically goes from infinitesimal at astronomical distances to the intensity of tertiary order attractors when collisions with atoms occur and to the intensity of secondary order attractors when collisions with ionized atomic nuclei occur.

We can however easily calculate the force between two heterostatic particles for a very well known astronomical distance, which is the distance between the Sun and the Earth (1.4959787E11 m). So to get an idea of the relative intensity of quaternary order attractors with respect the first three, let's calculate the force for this distance between one electron and a proton:

$$F = k\frac{e^2}{r^2} = 1.03088761\ \ 5E-50\ N \tag{4}$$

Of course if two atoms were involved, the force would be increased in proportion, and so on. From the estimated mass of the Earth (5.9742E24 kg), that of the Sun (M=1.9891E30 kg) and mean radius of Earth orbit we know that the force between Earth and Sun is:

$$F = G\frac{Mm}{r^2} = 7.543289846E22\ N \tag{5}$$

which hints at the astronomical numbers of particles making up both the masses of the Earth and the Sun.

Table II: Summary Table of Far Attractors

Table of far attractors		
Name	**Range**	**Related "Traditional" Force**
Temporary Far Attractor	Between any half-photon and each of the other heterostatic particles of the Universe	Electromagnetic
Quaternary Attractor	Between each particle of an atom and each heterostatic particle in the rest of the Universe	Gravity

Note that similarly to the first 3 orders of intensity attractors mentioned in **Table I**, complete description of quaternary attractors mentioned in **Table II** is available in Chapter "**23 The Force of Gravity**" of reference ([6]), including temporary far attractors, whose analysis is also out of context in this paper.

Let us now discuss the main object of this paper.

VI. NUCLEAR ADIABATIC EXPANSION AS ATOMS GET NEARER TO ONE ANOTHER

Considering that in a deuterium nucleus (**Fig.4**), the intensity of the secondary order attractors is sufficient to force each triad to slightly enlarge its translation orbit as put in perspective in Section H, and that it is consequently impossible for the translation velocity of each of them not to be slightly diminished in proportion, the only possible outcome of such an outward pull will be a slightly diminished measurable relativistic mass of each nucleon involved and consequently of the effective mass of the nucleus with respect to the sum of the measurable effective masses of its two components as measured when they are isolated.

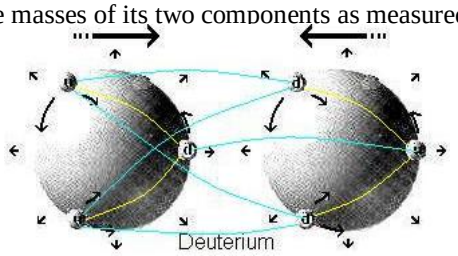

Fig.4: The Deuterium nucleus

It is then just as impossible, for the same reason, that the action of all tertiary order attractors in action at short range between the atomic nuclei making up a celestial body, each one captive at the centre of its own electronic escort, not to produce a similar effect on all triads of all atoms making up this body. That is a nuclear adiabatic expansion whose intensity will gradually increase from the surface to the centre of the celestial body.

VII. UNIDIRECTIONAL KINETIC ENERGY EXPRESSED AS A PRESSURE

Even though all atoms are in immediate electronic proximity to each other inside all masses, from the smallest meteorites to quasi-stellar masses, each elementary particle making up these atoms is still being subject to the acceleration resulting from the resultant of the action of the whole collection of attractors acting on each of them as a function of the inverse square law of the distance between them.

The complete analysis of unidirectional energy induction by acceleration is detailed in a separate paper ([30], Section VIII). But because these atoms are immobilized against each other into the best fit patterns allowed by the local electromagnetic equilibrium, the unidirectional kinetic energy induced between them can no longer express itself as relative motion in the direction determined by the resultant of the whole collection of attractors acting on each of them.

This unidirectional kinetic energy is thus unable to express itself other than as an adiabatic pressure that each atom exerts against its neighbors in the direction indicated by the collection of attractors acting on it (See **Fig.5**).

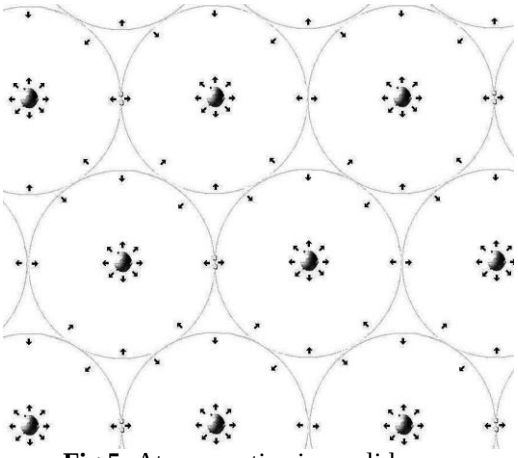

Fig.5: Atoms captive in a solid mass

This means that there is a direct equivalence between the instantaneous amount of kinetic energy induced by acceleration at a given distance between two free moving interacting particles and the amount of kinetic energy that would be induced in a stable manner by adiabatic pressure in the same two particles when they are captive at the same distance from each other within a solid mass.

VIII. ADIABATIC COMPRESSION OF ELECTRONIC ORBITALS

Although atomic nuclei are located too far inside their electronic escorts to be directly subjected to this pressure and contrariwise keep on being subjected to the local intensity of adiabatic expansion already mentioned, the external layers of the electronic escorts of these atoms are directly subjected to the adiabatic compression that this pressure induces.

The gradients of compression of each electronic escort and simultaneous expansion of each triad in the nuclei of each atom of each celestial body can thus generally mathematically be established, barring local singularities, as an infinite number of concentric strata whose intensity increases progressively towards the centre of each celestial body ([10], p. 222).

At the very centre of the Earth, for example, it seems quite certain that the pressure would be sufficient to force the outermost electronic layers to tighten and localize at distances from their respective nuclei shorter into the very intense high frequency magnetic field of the nuclei than if these atoms were isolated, ([7]).

At these shorter distances, the kinetic energy induced on these tighter orbitals will of course be greater than if these atoms were located at the surface of the Earth when surrounding matter is not pressuring them, as illustrated with the following 3D adiabatic range graph (**Fig.6**).

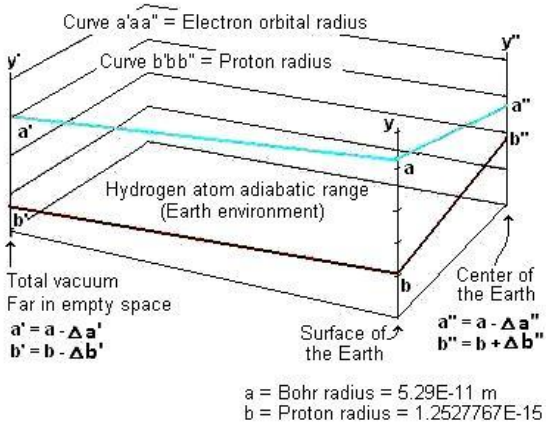

Fig.6: Hydrogen atom adiabatic range in Earth environment

Such a graph can indeed be drawn for each element in the Earth environment, as well as for each element in the environment of any celestial body, which includes all manmade satellites. See below an example of such a graph for the hydrogen atom in the Sun environment (**Fig.7**).

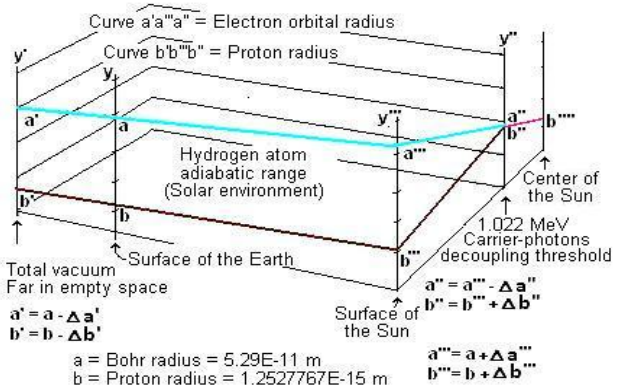

Fig.7: Hydrogen atom adiabatic range in Solar System environment

For bodies more massive than the Earth but having less than stellar masses, the following graph applies (**Fig.8**).

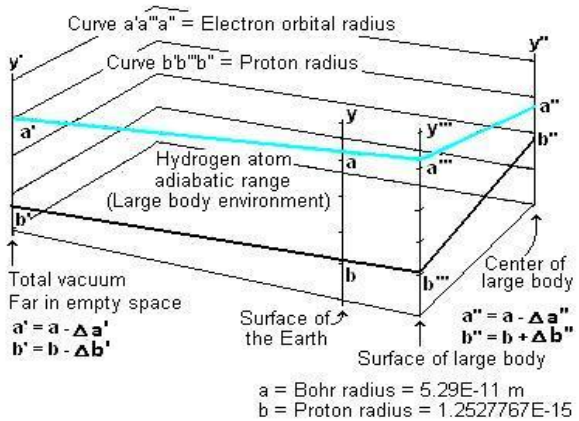

Fig.8: Hydrogen atom adiabatic range in bodies more massive than the Earth

For all bodies less massive than the Earth, the following form (**Fig.9**) is more appropriate to represent the complete possible range of adiabatic variation of the electronic orbital radius of atoms while also representing the simultaneous variation of the nucleons radius in their nuclei, and keeping the reference values known and measurable at the surface of the Earth.

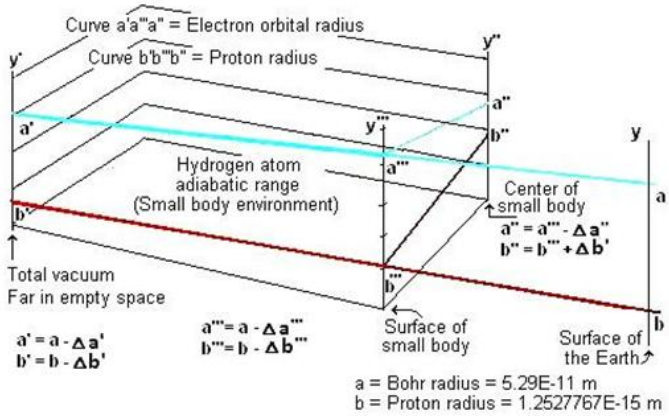

Fig.9: Hydrogen atom adiabatic range in bodies smaller than the Earth

IX. PRESSURE INDUCED HEAT INCREASE

The outcome of the adiabatic compression of atoms electronic escorts can only be a stable increase in the intensity of the local vibration (thus of the heat!) of the electrons located on those forcibly compressed outer electronic layers in the central area of planets that are sufficiently massive. There can be no doubt that it is this sort of pressure-induced excess energy that keeps the interior of planets hot as a function of their masses. This leads to conclude that the heat that keeps the centre of the Earth in fusion is strictly due to this irreversible adiabatic compression effect and will perpetually be maintained.

K. Pressure induced adiabatic heat increase

It is estimated that the heat at the centre of the Earth lies at about 5100 degrees Kelvin ([10], p. 223). One could then possibly expect that this heat would diffuse over time by conduction right to the surface, but it has been demonstrated that no energy induced by adiabatic compression can diffuse by conduction into less compressed areas unless it exceeds the intensity of the local gradient of temperature induced by the pressure.

The only way for this heat to diffuse into the less compressed areas is by convection ([10], p. 226), which is by circulation of hotter material towards less compressed areas. It seems that such convection fluxes naturally come into being inside central masses having become fluid inside sufficiently massive celestial bodies, which directly explains volcanic activity and tectonic plates motion on the Earth.

The energy generated by natural radioactive decay of unstable elements embedded into the mass is deemed to be a major factor in the increase of the inner temperatures above the adiabatic gradient, resulting in the establishment and maintenance of such convection currents.

These currents are established in a quasi stable manner in all planets and natural satellites of the Solar System where the inner pressure (temperature) becomes sufficient to melt the inner core as well as in the Sun. The resulting quasi stable temperature equilibrium of each such body is termed ***almost adiabatic stable state*** in geophysics.

X. THE 1.022 MEV CARRIER-PHOTONS STAR IGNITION THRESHOLD

It is totally logical that the more massive a celestial body will be, the higher the excess energy of the outer layers electrons carrier-photons of atoms located at the centre of these masses will be.

As described in paper **The Corona effect** ([11], Section V), Blackett and Occhialini discovered in 1933 the process by which photons of energy 1.022+ MeV convert to pairs of electron/positron ([18]) when they graze atomic nuclei ([16], p.17), a process dubbed "pair-production" very well known and understood in high energy accelerator circles.

Now, the energy in excess of the rest mass of a moving elementary particles such as an electron, has clearly been established as having the very same electromagnetic characteristics as those of a free moving photon, the only difference being that in the case of a moving elementary particle, this excess energy has to "carry", so to speak, the massive particle that it is associated with, hence its name of carrier-photon ([26]). It can then be fully expected that this carrier-photon, if it were to reach the 1.022 MeV threshold, would also be susceptible to decoupling.

For example, as interstellar hydrogen accumulates over time to form larger and larger masses, there comes a point for bodies reaching critical ignition stellar mass at the centre of which pressure has become sufficient for the 1.022 MeV decoupling threshold to be reached in a stable manner by the carrier-photons of the hydrogen atoms located at the very centre of such masses, as they are pressured to tighter and tighter orbital distances about the nuclear protons, an energy level represented as point **a"b"** on the adiabatic range graph of **Fig.10**, and chain decoupling of these carrier-photons will start naturally occurring.

In a stellar mass larger than that required for initial 1.022 MeV carrier-photons decoupling ignition triggering threshold to occur at its centre, which is the case for our Sun, now no doubt more massive than when it ignited long ago, this threshold will of course located at some distance from the centre of the star.

The decoupling threshold now occupies the thickness of a spherical shell within which, from point **b"** inwards, the adiabatic compression will now apply directly to the nucleons, now stripped of their electronic escort and that their radius will be diminishing as their relativistic mass increases under the pressure down to the level of point **b""**, that corresponds to the radius of nucleons at the centre of the Sun.

The reader will observe that the four 3D adiabatic range graphs presented previously represent all possible states of atoms in all possible sizes bodies in the universe, from the single isolated atom to the most massive super star.

The one common factor linking all of them is the combination of points **a'** and **b'** representing the smallest electronic escort radius combined with the smallest nucleon radius (thus highest mass for an atom at rest) that individual atoms isolated in deep space far from any concentration of matter can have.

L. The triggering threshold of the fusion chain reaction in stars

Let us summarily estimate at what distance inward towards the proton, the electron of each hydrogen atom located at the decoupling threshold depth within a star must be for its carrier-photon to reach this critical 1.022 MeV energy level, which is:

1 021 998 eV x 1.602176462E-19 = 1.63742E-13 Joules. (6)

With this energy in joules and the Coulomb equation, we obtain the following radius:

$$r = \frac{e^2}{4\pi\varepsilon_o E} = 1.408970142\,E-15\,m \quad (7)$$

As mentioned in Section III, nucleons radii are estimated to be in the 1.2E-15 m range, which means that the electron localized at this adiabatically over-compressed radius is only 0.2 E-15 meter away from the translation radius of about 1.2E-15 m at which the quarks of the protons are in translating motion at highly relativistic velocities!

Such close proximity to a proton (that is, of a quarks triad in constant cyclic motion at ultra high frequency and velocity) being precisely what causes free photons of energy 1.022+ MeV grazing atomic nuclei to decouple to electron-positron pairs, it certainly is logical that the electron carrier-photon forced by compression to a distance of 0.2E-15 m from the proton would also decouple, since it now has reached the decoupling threshold, but without any excess energy that would allow the newly formed pair to escape.

Let us note that the 1.2E-15 m proton radius is the translation radius of the quarks triad of a hydrogen nucleus at sea level at the Earth surface. But even supposing that adiabatic expansion of the hydrogen nuclei at such depth within stellar masses causes this radius to widen, it is doubtful that it could increase by 0.2E-15 to become equal to the decreasing radius of the associated electron before its carrier-photon reached 1.022 MeV, but this remains to be precisely estimated.

M. First stage neutron production and immediate capture

As the 1.022 MeV carrier-photon of the electron on its compressed orbit about the proton decouples, we end up with two electrons and one positron momentarily at a dead relative stop relative to each other in extremely close proximity to each other with momentarily zero residual energy available to move away from each other, while being subjected to high frequency attractive-repulsive interaction with the moving quarks of the nearby proton.

All odds are then that the three particles will have no choice but to start accelerating on closed orbits about each other according to the mechanics already explored to become a neutron ([11], Section VI) which, by immediately associating to the proton in its immediate vicinity will form a deuterium nucleus, while releasing the expected three very energetic bremmsstrahlung photons as the triad settles to the known approximate 1.2E-15 m radius of the newborn neutron!

Now the question immediately arises as to whether the Principle of Conservation of energy allows such a transformation, which involves three particles having the combined rest mass of three electrons transforming into a complex particle with a mass 1836 times that of an electron, that is, in this case 612 times the mass of the three initial particles. This possibility is thoroughly analyzed and justified in a separate paper ([30]).

N. First explosive ignition of stars

The energy liberated by the fusion of each newly created neutron with each already existing neighbouring proton will then cause a local excess energy far superior to that induced by the local adiabatic pressure gradient. This can only result in a fantastic explosion outwards of the whole central mass, involving all hydrogen atoms whose electrons' carrier-photons are reaching the decoupling threshold at the centre of the mass, thus triggering the irreversible nucleogenesis and nucleisynthesis chain reaction in this new star being born!

In this hurricane of liberated energy, it is more than probable that any free photon produced reaching the 1.022 MeV threshold will immediately decouple into a new electron-positron pair in a state immediately favorable to recombine in triads of both types (proton and neutron), freeing yet more energy. The statistically equal quantities of new protons and neutrons generated by this second stage process will then indefinitely continue being produced, guaranteeing the presence of the massive quantities of neutrons that are required for nuclear fusion to be maintained in stars at levels exceeding by far the adiabatic energy gradient.

It is logical also to conclude that the massive quantities of high energy bremmsstrahlung photons being produced by this second stage process could be the actual source of most of the radiated energy emitted by stars for those that would chance not to immediately convert to more electron-positron pairs, the much less energetic fusion energy released by nucleisynthesis becoming relatively marginal indeed as a source of the radiated energy.

Moreover, if such high intensity nucleisynthesis is constant from first star ignition, which seems more than likely, all elements of the periodic table will become abundant in stars early in their life, a conclusion that seems to be borne out by the recent discovery of a star (GRB 090423) whose age is estimated to be only 630 million years older than the hypothetic initial Big Bang and whose energy signature confirms the presence of quantities of metals similar to those of much older close by stars, including the Sun.

The production of statistically equal numbers of new neutrons as protons after the first explosive ignition of the star would also much more readily explain hydrogen fusion inside the Sun and other stars from natural proton-neutron combinations giving deuterium, followed by deuterium-neutron combination giving tritium, followed by tritium decay into helium-3, not even talking about the more massive nuclei that will certainly be created. (See paper [11] for an analysis of the possible nucleogenesis and nucleisynthesis processes of heavier nuclei in stars' coronas.)

O. Natural proton-neutron-proton fusion

The process of proton-neutron-proton fusion is quite easily reproducible experimentally, contrary to the proton-proton fusion hypothesized by Gamow that has been assumed for the past 70 years as fueling fusion in stars, but cannot be experimentally reproduced due to the insurmountable electrostatic repulsion between protons, a repulsion hypothetically deemed surmountable in the centre of stars only by pressure and temperature being applied, but that never could be proven in any of the attempted high pressure hydrogen fusion experiments.

The 3-spaces model confirms indeed that pressure is the prime mover in the process, but that it does not result in proton-proton fusion, but is rather responsible for the creation of neutrons, which in turn allows easy proton-neutron-proton fusion. In fact, the only successful cases of hydrogen fusion on the Earth involved massive amounts of thermal neutrons produced by fission detonators (atomic bombs), during experimental testing of unfortunately military motivated hydrogen bomb explosions.

XI. REPRODUCING THE CORONA'S EXTREME TEMPERATURE GENERATING PROCESS AND THE STAR IGNITION PROCESS

The question now comes to mind as to whether it would be possible for us to reproduce the neutron production process that ignites and maintains stellar masses in activity, or to harness the protons and neutrons generating process that seems to pervade the Sun's corona ([11]).

P. The Corona engine

It is not difficult to imagine what could become possible if we were able to consistently manufacture protons and neutrons from electron-positron pairs generated from the decoupling of simple 1.022 MeV photons, that the 3-spaces model clearly hints as being responsible for the corona's extreme temperatures as analyzed in a separate paper ([11]), which amounts to manufacturing matter from energy, instead of painstakingly extracting energy from matter as has been our only possibility up to now.

To put it bluntly, and not even taking into account the 227 fold increase in free energy that results from each nucleon creation, controlling as a first stage such a conversion process of two 1.022 MeV photons into 2.044 MeV/c^2 of mass (two electron-positron pairs), and then as a second stage, converting these 2 MeV/c^2 of mass to about 938 MeV/c^2 of effective mass (one hydrogen atom, that is one proton with its associated electron, or alternately one neutron with a free positron to spare) through an entirely natural and irreversible acceleration process, would provide us with about 470 times our stake masswise.

From all probabilities, the solution would fundamentally involve bombarding thin targets of still to be identified materials with massive amounts of highly focused photons of exactly 1.021 998 MeV energy, so that the decoupling pairs would have no energy to escape each other while being produced in sufficiently high concentrations and proximity for the triads to have a chance to form.

Regarding space exploration, it becomes possible to envision propulsion systems fueled by such photons, some sort of "corona engine" that would eject matter fundamentally created from pure energy in such huge quantities that constant acceleration at 1g could become possible, in spaceships the mass of which would no longer be a factor.

It would become possible to design hulls as thick as required, profile and magnetize them to efficiently protect crews against cosmic radiation and other particles, mostly produced as high energy protons collide with the hull, at the huge relative velocities that could be achieved.

Q. The Free Electron Lasers (FEL)

Interestingly, the technology already exists to implement the first stage of such a corona engine! The type of equipment required is currently being constructed and experimented with. It is named "**Free Electron Laser**" or **FEL**. One is being built/experimented with at the SLAC facility among others, and is for all practical purposes as small-scale wiggler, that can force a relativistic electron beam to synchronously oscillate between two arrays of magnets.

The beam can be modulated so that the frequency of the coherent bremmsstrahlung photons being produced can be finely tuned over a relatively wide range, theoretically up to the threshold frequency required for eventual pair production when directed at appropriate target material.

In 2009 already, experimentalists succeed in accelerating coherent electrons beams in a stable manner to energies of ~0.8 MeV by bombarding a silicon dioxide target with a system of highly collimated double laser pulses at a 500 times per second frequency ([22]).

This means that the day is not far when the magical carrier-photons 1.021 998 MeV energy level will be reached with coherent electron beams with such simplified devices that will be more easily adaptable for miniaturization and spacecraft motorization, and provide us with a source of energy available in unlimited quantities when completely controlled.

R. The Fusion Reactor

Regarding the star ignition process that initiates hydrogen fusion, compressing hydrogen gas to the required pressure for the carrier-photons of the hydrogen electrons to reach the precise triggering 1.021 998 MeV energy level could possibly be considered as previously analyzed, which would bring the electron carrier-photon close enough to the central proton of each atom to be immediately destabilized and converted to the required electron-positron pair, which would trigger the neutron creation process for each atom involved. But it seems doubtful that such pressure could be maintained at exactly the required value except fleetingly.

There exists however a two step process already well within our current technological capabilities, which consists in first accelerating coherent electron beams to the required precise velocity required for their carrier-photons to reach the critical 1.021 998 MeV energy level, which in joules amounts to 1.637420828E-13 J.

This electron carrier-photon energy is reached at the fantastic electron velocity of 259 627 884 m/s, which is 86.6% of the speed of light, and then to cause these electrons to meet target material that will simulate the proximity of the hydrogen proton nuclei in the central area of stars.

The outcome would be crowds of deuterium nuclei that could be used to sustain hydrogen fusion if coupled with the corona process.

S. Critical and supercritical velocities

Readers familiar with high energy accelerators are well aware that such velocities are easily reached and even by far exceeded up to 99.99…% of the speed of light for beams of collimated electrons in circular accelerators, and this since the 1960's. Shouldn't we then have observed this neutron generating phenomenon quite often for such supercritical velocities?

Indeed we probably observed it quite often as fleeting by-products of the experiments carried out! It must be clearly understood that the decoupling into pairs of high velocity electron carrier-photons does not depend only on the electrons having reached the critical velocity. Some destabilizing condition must be present to trigger the process at the precise triggering velocity required, or else this velocity can be exceeded and pushed as far into the supercritical range that technology will allow without any decoupling to occur.

At the precise velocity required however, the least interference in the path of the beam by any particle, be it stray or planned, is likely to trigger decoupling. The explosive traces of such occurrences must have been recorded for study for the past 5 decades.

But since the purpose of these experiments was to detect the most massive partons that technology allowed, these collisions have traditionally been carried out at the highest possible velocities. The carrier-photons' energy then almost systematically exceeding the precise amount of 1.021 998 MeV required, makes it doubtful that more than a few stray neutrons would directly materialize, which seems to be precisely what has been observed ([21]). See also [6] **Section 20.2**.

XII. THE ANOMALOUS ACCELERATION OF PIONEERS 10 AND 11

Since the rest mass of complex particles and bodies (mostly made up of relativistic mass as was put in perspective at the beginning of this paper and completely analyzed in a separate paper ([30])) varies by adiabatic interaction in relation with the local intensity of gravity, then any local increase in gravity will obviously cause nucleons to adiabatically dilate, thus decreasing their effective mass, while any local decrease in gravity will cause them to adiabatically contract thus increasing their effective mass.

This last point seems to be the major stumbling block preventing Special Relativity from explaining quite a few up to now unexplained and apparently unrelated phenomena, among which the so-called “anomalous” acceleration of far spacecrafts Pioneer 10 and 11 on their hyperbolic trajectories.

Indeed, Special Relativity was never adapted to take into account the adiabatic variation of the relativistic mass of nucleons with local density of surrounding matter inherent to the now well understood internal structure of nucleons.

We just analyzed how the attractive electrostatic force between all charged particles acts in such a manner that the closer the triads will be to the geometric centre of a heavenly body, the more their diameter will be forced to increase inside their adiabatically being compressed electronic escort (**Section VIII**), under the combined action of the tertiary order attractors that link their components to all other heterostatic particles making up the other atoms in the body, and the more their angular momentum, thus their energy, or inertia, made up of the quarks rest masses plus their relativistic mass increase due to their velocity, will consequently decrease.

Even the triads of atomic nuclei located at the surface of the Earth, for example, are sufficiently slowed down by this adiabatic process for the difference to be measurable in comparison to atoms of the same elements located far above the surface. Let us note here however that atoms located at the surface of the Earth are not adiabatically compressed by the pressure of surrounding atoms as is the case under the surface.

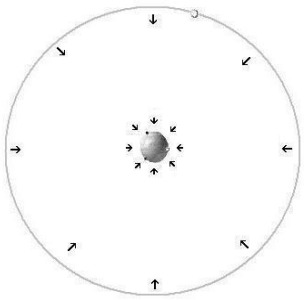

Fig.10: Hydrogen atom isolated in deep space

When small quantities of matter are elevated away from the gigantic mass of the Earth, the electronic layers as well as the nucleons of the atoms concerned will contract (**Fig.10**), not caused by adiabatic pressure in this case but due to a general weakening of the strength of all electrostatic attractors between them and the mass of charged particles making up the receding Earth, contrary to what happens to atoms under the surface, that suffer compression of their electronic layers while at the same time suffering an expansion of their nucleons (see **Section VIII**).

It has been experimentally verified that cesium atoms located high above the surface of the Earth emit higher frequency photons when some of their electrons jump from the reference metastable orbital to a more stable inner reference orbital, due to mean distances of each electronic escort to its own nucleus becoming shorter than for identical atoms located in reference cesium clocks resting at the surface of the Earth.

This drift of the "local effective mass" of atomic nuclei related to the translation diameter of the triads that ambient intensity of electrostatic interaction which up and down quarks of the nuclei of surrounding atoms imposes on them still has to be taken into account in Special Relativity and has up to now been interpreted in the case of atomic clocks as an increase in time rate with altitude.

But if this dependence of nucleons masses on the gravity field intensity gradient was taken into account, the equations of Special Relativity could directly account for the numerous and apparently unrelated phenomena that we will soon discuss, among others for the faster rate of atomic clocks with altitude without any need to resort to the time dilation concept, and would no doubt help calculate more precisely the hyperbolic trajectories of far spacecrafts such as Pioneer 10 and 11, as well as those of all other very small orbiting bodies.

The change in "effective local rest mass" of atomic nuclei in relation with the proximity of large quantities of other atoms is precisely what was demonstrated with the experiments carried out by Häfele and Keating with identical cesium clocks on the ground and at an altitude of 10 km, experiments meant to demonstrate that time runs more slowly at the surface of the Earth than at a distance from it. Presently, the mean electronic orbits of cesium atoms, whose mean radii depend on the density of the nucleus, will of course tighten towards the nucleus when the triads contract with altitude.

The frequency of the photons that the microwave oscillator serving as a time calibrating reference for these clocks will have to emit will then have to be increased with altitude for the cesium atoms to continue hitting the target, with respect to that of corresponding photons emitted for the corresponding quantum jumps in atoms of the same element whose triads will be less dense at the surface of the Earth ([2], p.8). The Hàfele and Keating experiments effectively showed that the clocks carried in altitude had "apparently" gained 100 nanoseconds with respect to those that remained on the ground ([12], p.182), but not due to time dilation as assumed, but due to nucleon rest mass increase as revealed by the 3-spaces model.

As analyzed, protons and neutrons can reach their maximum local effective rest mass, that is, their smallest rotation diameter, only when they are deep in space, far from any planetary masses, where all adiabatic interaction with these large masses becomes infinitesimal (**Fig.10**).

It seems that it is exactly what was demonstrated by the supposedly "anomalous" and still unexplained constant residual acceleration directed towards the Sun of spacecrafts Pioneer 10/11, Galileo and Ulysses ([13], p.1) on their escape trajectories from the Solar system. This issue could possibly be resolved in great part, if not completely, if the variation of local effective rest mass was used in these hyperbolic trajectories calculations. The Special Relativity equations would then remain valid even if the notion of time dilation was taken out of the picture.

All of these spacecrafts presently behave exactly as if they were slightly more massive as they run their hyperbolic trajectory than was measured at the surface of the Earth before launch, which is consistent with the analysis that we have just carried out.

XIII. UNEXPLAINED EXCESS ACCELERATION DURING CLOSE FLYBYS

The same type of behavior was observed, apparently involving an unexplained excess acceleration directed towards the Earth, for two close flybys of Earth in the Galileo trajectory in December 1990 and

December 1992 ([14], p.6). Note that these encounters occurred in December, when the Earth is at perihelion (closest to the Sun on its elliptical orbit). We will discuss this shortly.

These flybys, called **Planetary Gravity Assist**, are used to modify trajectories and increase or decrease spacecrafts velocities far beyond what can be achieved with current technology man made boosters.

A systematic so-called "anomaly" treated separately from the sunward Pioneer 10 and 11anomalous acceleration has been noted for all crafts that have used the flyby technique ([15]). What has been noted for all crafts for which sufficient data was recorded, is a higher than expected velocity peak at the closest point to the planet of the flyby trajectories of all of these crafts.

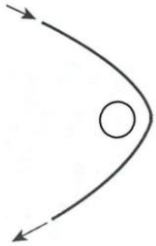

Fig.11: Close spacecraft flyby

Data on record for all Earth flybys by spacecrafts Galileo, NEAR, Cassini, Rosetta and Messenger show this systematic and unexpected peak in velocity and also that the crafts had more energy on the outward leg of the flyby than calculation can account for, assuming constant rest mass of the crafts. The closer the craft came to the planet, the higher the velocity peak turned out to be.

The same velocity peaks were also observed from the data on record for the Pioneer 10 craft on its Jupiter flyby and for the Pioneer 11 craft on its Saturn flyby, both of which sent the crafts on their final escape hyperbolic trajectories out of the Solar system.

Anderson et al.'s paper on this issue ([15]) clearly shows that the rest masses of the crafts are assumed to be constant. The reader certainly understands by now that had the variation of rest mass as a function of the distance from the planet during the flyby been taken into consideration, diminishing on the inbound leg and increasing again on the outbound leg, these velocity peaks would indeed have been expected and found to be normal, since the kinetic energy that the crafts possessed before closing in, now increasing further from the planet's increasing attraction, progressively applied to their now constantly diminishing masses as they got nearer to the planet.

As for the excess velocity observed on the outward leg, it is easily explained since the full effect of the momentum transfer from the planet occurs while the triads making up the nuclei of atoms of the crafts are at their maximum adiabatic expansion, thus their least massive state, an energy that will be conserved as the triads progressively contract again as the crafts moves away from the planet.

Interestingly, the Anderson et al. paper ([15], p.19) does mention the possibility of "missing mass" to explain away the anomaly, but just as an as yet unexplored *a priori* possibility.

But up to now, all computations have been made using the masses of the spacecrafts as effectively measured before launch at Earth-ground level and without taking the time of year into consideration, since one of the fundamental premises of contemporary physics is that the rest mass of bodies is universally invariant, an assumption that our analysis reveals as being a physical impossibility for all complex bodies including nucleons.

So, an appropriate correction taking into account the individual increase in effective rest mass of all constituent atoms of the spacecrafts on account of their being located in space far from large planetary masses should therefore nicely iron out the problem.

The corrective factor required to obtain the "local effective rest mass" that should be used with respect to altitude can be obtained by analyzing the curve of increase in frequency of cesium clocks from ground to deep space, and be confirmed by applying it to the calculation of the trajectories of Pioneer 10 and 11.

XIV. CYCLIC ANNUAL VARIATION IN EARTH'S ROTATION RATE

Now the question arises as to whether there exists experimental data that could in no way be interpreted as a variation of the time rate and that would confirm out of any doubt that it would be only the variation of the rest mass of cesium atoms that could explain the atomic clock rate increase with altitude.

Indeed, if the rest mass of complex bodies really varies as a function of the local intensity of the gravity gradient and if such a variation really is at play in the case of atomic clocks frequency variation and the Pioneer spacecrafts hyperbolic trajectories as the 3-spaces model predicts, this should definitely be a universal characteristic of all complex masses and affect all existing matter in a way that should be verifiable, shouldn't it?

Interestingly, the answer is yes, there does exist experimentally obtained data consistent with this prediction of the model!

In the 1950's, as the precision and stability of caesium atomic clocks was being compared to the assumed stability of the Earth`s rotation rate (**Fig.12**), it was discovered that this rate is measurably higher during northern hemisphere summer, when the Earth reaches its farthest point from the Sun, namely the aphelion, than during winter as the Earth reaches its closest point to the Sun, namely the perihelion, on its elliptical orbit ([2], p.10).

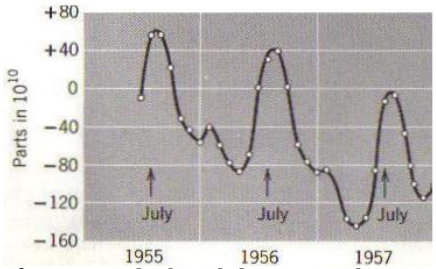

Fig.12: Graph of caesium clock stability vs Earth rotation rate stability

In the 3-spaces model, this data is consistent with a process by which, as the Earth progressively moves closer to the Sun towards its perihelion on its elliptical orbit, the orbits of the up and down quarks triads of which the nuclei of the atoms that make up its internal mass would suffer adiabatic expansion due to the increasing intensity of the gravity gradient between it and the Sun, causing a relativistic slowdown in their local rotation by slackening the radius or their local orbits thus a lessening of the relativistic component of their mass, leading to a corresponding increase in volume of the Earth and a decrease of its total mass that would lead to the observed rotation rate slowdown.

On the outward leg of the orbit, the triads would progressively tighten again towards a maximum that would be reached at aphelion as the whole process reverses, by internal adiabatic compression of the triads' orbits as Sun attractive force diminishes due to increasing distance, resulting in the increased Earth rotation rate observed. It goes without saying that the orbit of the moon would vary in accordance, expanding towards perihelion and contracting towards aphelion.

But since the momentum of the Earth remains constant, this would also induce a related momentary extra velocity factor due to its diminished mass that could well directly explain why its orbit precesses as observed.

So even if the eccentricity of earth's orbit is very small (0.016710219), this rest mass variation effect of the Earth is nevertheless just as clearly detectable as the increase in frequency of atomic clocks being taken barely 10 km away from the Earth's surface.

However small the eccentricity of Earth's orbit, it is sufficient to bring the earth 5 million kilometers closer to the Sun at perihelion than at aphelion, which is about 13 times the distance between the Moon and the Earth!

XV. EARTH'S ROTATION RATE PROGRESSIVE SLOWING DOWN

Let's now examine other experimental data that could be associated to a similar adiabatic process at quite larger scale, that is, the galactic scale! The same experiment (**Fig.12**) brought to light another quite surprising and unexpected result.

It was discovered that the Earth rotation rate was slowly and steadily decreasing year after year! Could it be then that the Earth and the whole Solar system would be undergoing a gravitational effect similar to that of the Earth on a local scale as it moves on the inbound leg of its elliptical orbit? This would of course directly focus our attention on the orbit that our Solar system moves on about the centre of our own Galaxy!

XVI. MOON ORBIT PROGRESSIVE WIDENING

And there also is this other apparently unrelated effect that now becomes intimately related. Using the Lunar Laser Ranging Experiment, the McDonald Observatory in Texas and other observatories confirmed that the Moon orbit is slowly receding from the Earth at a rate of about 3,8 cm per year!

Better yet, on August 19 of 2010, NASA's Lunar Reconnaissance Orbiter (LRO) confirmed that the Moon has shrunk by about 100 meters since the 1970's, which is entirely consistent in the 3-spaces model with an expected contraction of the Moon having been receding away from the Earth by more than one meter since the mid 1970's, as all of its atoms would logically have been shrinking in diameter as they were less and less attracted by the receding mass of the Earth, a process that can be fully expected to go on until the Solar system reaches perigalacticon (see further on).

XVII. CYCLIC SOLAR SYSTEM GALACTIC ORBIT VARIATION

Wouldn't this be consistent also with the Earth slowly expanding and becoming progressively less massive in the same manner as it appears to become each time its moves on the inbound half of its elliptical orbit towards the sun?

As the whole Solar system is being drawn closer to the centre of the galaxy, as it is nearing the end of the inbound half of its orbit towards some "perigalacticon" of the galactic orbit of the Solar system, the whole solar system is progressively being drawn deeper into the gravitation field of the galaxy, causing all nuclei making up all atoms in the solar system to progressively expand and diminish in mass.

Note that this global low intensity triads expansion process of all triads in the solar system caused by the whole solar system slowly moving deeper into the galactic gravity field is acting in opposition to the process of contraction of all planetary and other small orbiting bodies triads due to the locally progressive widening of

all orbits in the solar system which causes them to progressively move away into the locally much stronger gravity field of the Sun.

This particular low level galactic gravitational effect would certainly affect all bodies and orbits in the Solar System in a manner that certainly could be verified! Don't we observe that the world's scientific community has been trying to explain for decades why the standard kilogram stored in Sèvre, France, since 1879 seems to progressively diminish in mass with respect to all official copies made of this mass and stored all over the world, or alternately that the official copies have been gaining mass with respect to the reference kg, whichever may be the case. We will analyze this issue in the next section.

Now, the galactic orbit of the Solar system is effectively orders of magnitude larger than that of Earth's orbit about the Sun. The galactic "year" is estimated to last between 225 and 250 million years. Our galactic orbit is also almost circular like that of the Earth about the sun, but it is nevertheless at 0.07, which is approximately 5 times more eccentric than that of the Earth.

Perigalacticon (the point of our galactic orbit closest to the centre of the galaxy) is estimated to be 27,600 light years away from the galactic centre while the farthest distance at the other end of our trajectory is estimated at 29,532 light years away from the centre, that is, a whopping 1932 light years difference!

From data currently available, we should currently be a about 27,700 light years away from the galactic centre, on our way to perigalacticon, that we should reach in about 15 million years, which is totally consistent with interpreting the 1950's data as meaning that we are in the second half of our galactic inbound orbit about the galactic core, and which is consistent with an effect of progressive expansion of the orbits of all bodies in the Solar system.

Given that the current Earth-Moon centre to centre distance is now 384403 km and that for the next 15 million years, this distance is going to increase at a rate of about 0,038 m/year (not precise since this figure is decreasing slowly to reach zero as we reach perigalacticon, but fine for such ballpark figures), it can be stated that the maximum mean distance that the Moon orbit will reach at perigalacticon will be approximately 570 km more, giving 384973 km and that at the other end of the galactic orbit, about 115 million years later, this distance will have lessened by 3450 km letting the Moon orbit come to its nearest mean distance to the earth at 380603 km, this fluctuation of the Moon orbit between these maxima and minima being of course repeated each galactic year.

Verifying if the rate of increase of the earth's rotation rate slowing down is diminishing would definitely confirm a link between this currently unexplained planetary slowing down and our current position on the galactic orbit and Moon recession associated to increasing rest masses in the 3-spaces model.

We also know that our galactic orbit is most certainly stable, since such stability within limits compatible with life being maintained on the Earth have obviously prevailed for the last tens of these galactic orbits (it is estimated that 18 to 22 such orbits have been completed since the solar system came into being.

This stability also allows predicting that in 15 million years, as the Solar system starts on its return journey on the outbound leg of its elliptical orbit about the galactic core, the Moon will start closing in again and Earth's rotation will start increasing again like those of all other Solar system bodies towards cyclic minimum distances and maximum mass densities as the cycle completes, before starting again the next inward leg of the orbit, towards perigalacticon.

XVIII. MASS VARIATION DURING SOLAR ECLIPSES

Let us now examine another phenomenon that can possibly be associated to rest mass variation as a function of local gravity intensity. It is a phenomenon first observed by Maurice Allais in the 1950's. During the solar eclipse of June 1954, and also during that of October 1959 ([31], p. 152 à 169), he collected data with a paraconical pendulum (modification of the Foucault pendulum) that seemed to indicate that the local intensity of gravitation was slightly diminished for the whole duration of the eclipse (2.5 hours), an experiment that earned him the Galabert prize in 1959.

This double observation was also confirmed during the 1961 total solar eclipse in Romania, when a team led by G.T. Jeverdan observed a similar phenomenon with a Foucault pendulum. It must be said here that the Jeverdan team had not heard yet of Allais's results at the time. They discovered his results to their surprise only in 1962 as they were preparing their report.

Other researchers have also conducted experiments to confirm these results with other types of apparatus. Some confirmed, others not. Could it be that the type of equipment being used has a role to play? Could it be that only paraconical or Foucault pendula would be appropriate devices for such observations for a reason yet to be identified? The future will tell.

Numerous questions have been raised besides the Allais effect by data gathered during solar eclipses. These issues have been synthesized with exhaustive references in two recent papers, one by Russell Bagdoo ([32]) and the other by Thierry de Mees ([33]).

Now, how could the results of Allais and Jeverdan be interpreted in the present model, if they eventually were definitively confirmed? We already understand that when the Earth reaches perihelion (closest point to the Sun of its orbit), its rest mass becomes mandatorily less because it is closer to the Sun than anywhere else on its orbit due to already explained nucleon expansion. Let us consider that when the Moon passes between the Earth and Sun during an eclipse, the whole mass of the Moon adds its gravity field vectorially in the same direction as that of the Sun.

Could it be that the momentary presence of such a large mass this close to the Earth in the same direction as that of the Sun would have a momentary effect similar to that which occurs when the Earth is near

perihelion, which would locally further decreases Earth nucleon masses in the path covered by the moon during the eclipse?

Such an effect has to be permanently present between the Moon and Earth and should follow by nature the high tide point as the Moon circles the Earth, with the effect being at maximum where the axis linking the centres of the Moon and Earth meets the surface of the Earth. A similar effect of course has to be in action along the axis linking the centres of the Sun and Earth, but during an eclipse of the Sun, both effects do add up as both axes meet the surface of the Earth very close to each other.

Here again, the lunisolar periodicities discovered by Maurice Allais with the paraconical pendulum seem to confirm the permanence of these interactions between the Moon and the Sun on one side and the Earth on the other and that are the consequence of the dependence between the rest mass of nucleons and the intensity of the ambient gravity field as described in the 3-spaces model.

XIX. THE STANDARD KILOGRAM MYSTERY

T. Brief History

It is well documented that the standard kilogram stored in Sèvre, France, meant to be the universal standard mass unit for the SI measurement system, has been and still is the cause of major head scratching in the scientific community.

Originally meant to be part of a system unifying measurements, it was defined in 1795 as the mass of one cubic decimeter (1/1000 of a cubic meter, also defined as one litre) of distilled water at maximum density (276,984^{o} Kelvin) at one standard atmosphere. However, the connection between the standard kilogram and the cubic decimetre was cancelled in 1960 after renewed measurement revealed that the reference one cubic decimetre of distilled water at maximum density now had a density of 25 millionth of kg less than the Sèvre reference kilogram, with maximum error margin of only one millionth! See Section XXI further on for a possible explanation of the relative difference in triad expansion rates between light and heavy elements.

Does this mean that water had become measurably less dense in 1960 than it was 200 years sooner, possibly linked to a slow nuclear expansion related to the Solar system galactic trajectory? Or that the length of the standard meter had drifted during this period? One thing is certain, the measurement techniques available two centuries ago already allowed precision in the 1 part per million range and the utmost care was lavished on all procedures spreading over many decades to insure accuracy.

The reference kilogram produced in 1879 is a cylinder made of 90% platinum and 10% iridium, 39.17 millimeters high and 39,17 millimeters diameter stored in optimal conditions in Sèvre (**[27]**). This alloy was chosen on account of its exceptional hardness and resistance to oxidation.

Official replicas were manufactured to within a few micrograms of the official Sèvre kilogram and sent to all participating countries where they were stored in similar conditions. Approximately every 50 years, each replica is carefully measured and compared to the Sèvre kilogram.

These periodic verifications have been cause of concern in the scientific community because despite all the care taken, all replicas appear to have gained mass over the course of the past two centuries relative to the initial official Sèvre kilogram sample for a variety of reasons, some known, related to ambient contamination and cleaning procedures, and some that considered still unknown. The reality is that the masses of the complete set of all official replicas have been progressively diverging over time and that the original Sèvre kilogram seems to have lost about 50 micrograms with respect to the set of replicas.

It is not known what interpretation should be given to the phenomenon, for there are many and here are some of them: 1) the Sèvre kilogram would be stable while the replicas gain mass over time. 2) The Sèvre kilogram would be losing mass while the replicas gain mass. 3) All kilogram samples would be gaining mass with the initial kg gaining mass less rapidly, etc…

The correct interpretation will become possible only when comparative volume measurement are accomplished over extended periods of time on the various official kilograms with the recently and permanently stabilized "meter" unit now referring to the invariant speed of light since it is not known (or studied) yet whether the volumes of the various reference masses have been also varying over time.

A variety of methods have been proposed to resolve the issue by defining a new standard for the kilogram that would be stable over time, like the new "meter" standard has now become. Some involve counting the atoms in a new reference mass, others involve accelerating known masses, etc. One of the methods most seriously considered involves defining the kg in terms of the Planck constant (h) termed the Avogadro project (**[23]**). Another, conducted in the US, involves measuring the electric power required to hold a mass of 1 kg against the force of gravity, termed the Watt balance project (**[24]**).

However, all of the proposed methods ultimately involve masses made up of atoms, that our analysis demonstrates as possibly varying with the intensity of the local gravity field, being opposed one way or other to the local intensity of the gravity field.

U. The State of Knowledge about nucleons

Since full understanding of the nature of the forces involved inside nucleons has not yet been achieved, there remains a possibility that a relativistic mass component be an important fraction of the measured rest masses of atomic nuclei as revealed by analysis of the 3-spaces model. Such a component may be all the more important since the experimentally confirmed possible range of masses of the only scatterable massive sub-component of nucleons (up and down quarks) represents such a small fraction of the measurable rest masses of nucleons.

Table III: Summary of nucleon components masses

Summary of nuclear components masses			
Particle	**Estimated mass**	**Mass converted to Kg**	**Reference**
Electron	0.510998910(13) MeV	9.10938215(45) E-31 kg	([29])
Up quark	1.5 to 5 MeV/c^2 (estimated)	2.049610923E-30 kg (approximate)	([28], p. 11-6)
Down quark	3 to 9 MeV/c^2 (estimated)	8.198443779E-30 kg (approximate)	([28], p. 11-6)
Proton	938.272013(23) MeV	1.672621637(83) E-27 kg	([29])
Neutron	939.565346(23) MeV	1.674927211(84) E-27 kg	([29])

Simple calculation from the maximum estimated MeV figures for the quarks shows that the massive scatterable sub-components in a proton (uud) represent only about 19/938 = 2% of its measured rest mass. Similarly, the only massive sub-components in a neutron (udd) represent only about 23/939 = 2.4% of a neutron measured rest mass. A large part if not all of the remaining mass of both types of nucleons then seems to be relativistic in nature due to the highly relativistic velocities of the quarks captive on their closed orbits, which presumably define the volume occupied by nucleons.

Indeed, relativistic effects being tied to the velocity of massive particles and up and down quarks being massive and consequently subject to gravity, these velocities are by nature dependent on the local gravity field intensity gradient which is well documented to vary with location and altitude with respect to the Earth surface and that the rest masses of nucleons have to be variable to some extent.

However small these variations may be at the sub-atomic level for each nucleon in the possible range of the gravity gradient covering the various locations and altitudes of the surface of the Earth where the standard kilogram copies are stored and tested, they may possibly amount to a measurable difference for masses as large as the 1 kilogram reference standard.

Three other factors need to also be taken into account. First, the position of the mass of the Moon with respect to the location where calibration measurements are taken, which represents a possible relative distance swing of up to 13000 km of the lunar mass due to the daily rotation of the Earth, in subtraction from the mass of the Earth when the Moon reaches the zenith relative to the measurement location and in addition as it reaches the relative nadir; second, the cyclic variation in the local gravity field intensity from the Sun as the Earth-Sun distance varies on a yearly basis (a cyclic swing of about 5 million km), and third, the distance in the process of decreasing between the Solar system and the centre of the galaxy due to the much longer cycle of the motion of the whole Solar system on its elliptical orbit about the centre of the galaxy.

The first two cases can of course be minimized if measurements were to be taken at the same time of year and of the Moon cycle. These variations bring into perspective the possibility that any attempt to define an invariant mass standard involving complete atoms may be doomed by nature to be valid only locally and temporarily!

This raises the crucial question of what existing mass other than the various types of atoms could be used as an ultimate invariant mass reference to guarantee permanent stability over time?

V. A Universal and Invariant Mass Standard

Analysis of massive particles other than atomic nuclei reveals that the only other particle for which there is absolute certainty that its rest mass is totally invariant across the universe, irrespective of gravity field intensity variations is the electron (or positron) whose rest mass can harbour no relativistic component whatsoever since it is elementary (having no internal sub-components), on top of having the smallest measured uncertainty margin of all massive particles (0.00000045 E-31 kg), when compared to both types of nucleons (0.000 000 084 E-27 kg), that is, a 5 orders of magnitude smaller uncertainty margin!

We have been accelerating electrons for more than a century and can even accelerate and detect individual electrons in more than one manner. Consequently, it would be possible to develop a special type of cathode ray tube to very precisely measure the invariant rest mass of the electron that could easily be produced in identically calibrated quantities to be used all over the world for the required reference needs (**Fig.13**).

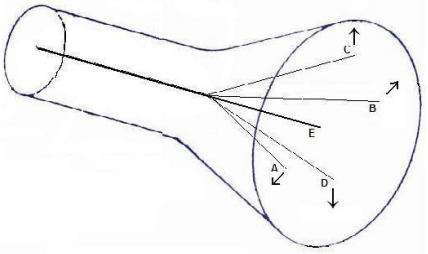

Fig.13: Invariant mass calibrating cathode ray tube

Defining very precisely tuned energy levels and guiding magnetic fields is largely within our technological abilities and only involves deflecting electrons in 4 separate directions: A and B being deflected horizontally respectively left and right at the same level in the gravity gradient; C being deflected vertically up into the gravity gradient and D down deeper into the gradient. with E being a reference projection suffering no deflection.

The neutral reference target E would be located at the geometric centre of the screen and the four peripheral targets would be located at equal distances from target E. The screen must be curved so that all 5 beams run exactly the same distance to their respective target from the point of emission.

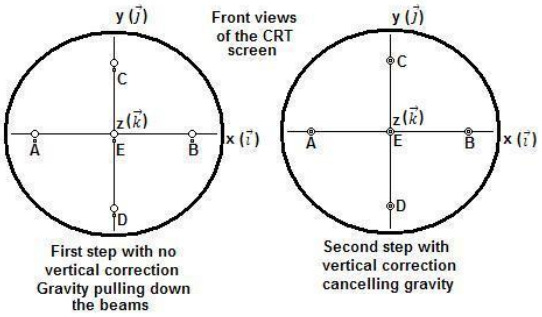

Fig.14: Frontal view of the invariant mass calibrating cathode ray tube

The first frontal view (**Fig.14**) shows where the impact points of the 5 electron beams would be if the correct energy was applied and their trajectories deflected towards the exact centres of the 5 targets, with no correction being applied to take gravity into account (as if the apparatus was in free fall). The energy used to liberate the electrons from the cathode oriented from the back of the tube towards the front determines of course, the velocity of the 5 beams:

$$E_A\vec{k} = E_B\vec{k} = E_C\vec{k} = E_D\vec{k} = E_E\vec{k} \qquad (8)$$

The second frontal view in **Fig.14** shows the beams directly aligned at the centre of their respective targets after the guiding magnetic fields have been adjusted to exactly counteract the effect of gravity. This configuration amounts to perfect calibration of the device at the location where it is going to be used. In this configuration, beams A and B are of particular interest since the two magnetic deflection corrections being applied to them are exactly normal to each other, lateral deflection exactly parallel to the x axis and vertical deflection exactly parallel to the y axis, which simplifies calculations.

So from the energy level adjustments of the various fields required to perfectly align the beams on the targets, it becomes possible to calculate the exact rest mass of the electron by subtracting the relativistic component due to its velocity and that due to the gyroradius of their deflection.

An appropriate amplification of the energy allowing these calculations would then allow very precise calibration of specially designed balances anywhere in the world without reference to the local gravity field from the behavior of a particle whose rest reference mass is universally invariant.

The energy levels observed for beams C and D at various locations would no doubt allow gathering interesting extra data regarding the gravity field in the Earth environment, since the magnetic correction that must be applied vertically parallel to the y axis will by definition be slightly less for beam C, located above beam D in the gravity field gradient.

XX. NUCLEAR BINDING ENERGY

Another clue supporting the conclusion that atomic nuclei rest masses depend directly on the number of nucleons present in the immediate vicinity is related to the so-called binding energy between the nucleons in atoms. It is well verified that the more numerous nucleons there are in any given atomic nucleus, the less massive each nucleon is.

It is well known for example that when a uranium 235 atom decays, the sum of the masses of the resulting smaller atoms and escaping neutrons is larger than that of the initial uranium atom.

In fact, the "binding energy" of the classical interpretation, for example the mass default of a deuterium nucleus with respect to that of an isolated proton and neutron, can only be due in the 3-spaces model to the adiabatic expansion of both triads of the proton and neutron in the deuterium nucleus due to their closer proximity, resulting in their diminished relativistic mass (see Section H)!

But then, what about the energy liberated when a deuterium atom is created as a neutron joins a hydrogen nucleus (a proton)? The answer is simple in context and can be summarized with one word: bremmsstrahlung! That is the energy liberated at final stop after the terminal acceleration of both proton and neutron towards each other. See separate paper ([30], Section VIII) for an analysis of bremmsstrahlung release related to particles acceleration.

It is verified that all nucleon fusions are exothermic in this manner up to the iron atom in the periodic table of elements, mass beyond which they become endothermic, which is why only rapid neutrons are likely to integrate into more massive nuclei to increase nuclear masses.

XXI. CONCLUSIVE EXPERIMENTAL PROOF EXPERIMENT

Finally, we must wonder whether an experiment could be conducted that could validate without the shadow of a doubt this major conclusion of the 3-spaces model that rest mass of nucleons, mostly made up of relativistic mass as put in perspective in this paper and in separate paper ([30]) really varies by adiabatic interaction in relation to the local gravity gradient. An experiment whose results could in no way be interpreted as demonstrating time dilation.

If such a process of nucleon dilation really is in action, then any increase in local gravity intensity will obviously cause nucleons to adiabatically dilate as the velocity of the captive quarks defining their volume diminishes, thus decreasing the relativistic fraction of their measurable rest masses, while any local decrease in gravity intensity will cause them to adiabatically contract thus increasing the relativistic fraction of their measurable rest masses.

All probabilities are then that less densely packed nuclei such as those of lithium or magnesium for example would have a nucleon contraction gradient towards maximum density more pronounced as local gravity intensity decreases than those of denser elements such as uranium or osmium, given that they contain much fewer nucleons in volumes of about the same order (The diameter of denser atoms, including electronic escorts is estimated at only about 3 times that of hydrogen, so the ratio between lightest and densest metals will be lower yet), meaning that nucleons of less dense elements should contract more rapidly towards their limit than those of denser elements as they are lifted in altitude away from the surface of the Earth.

To conduct such an experiment, only an equal-arm balance would be required with which two masses of widely different densities would be set in perfect equilibrium at ground level, or better yet, at the bottom of the deepest mine shaft possible, and that this assembly then be lifted in altitude as high as convenient for direct observation.

If the nucleons contraction gradients really are different for low and high density elements, then the side holding the low density element should go down as altitude increases, showing that the less dense element is now becoming more massive than the higher density element, both of which having had exactly the same measured mass when first put in equilibrium at the beginning of the experiment at ground level or at the bottom of a deep mine shaft, thus conclusively proving the validity of the 3-spaces model.

XXII. CONCLUSIONS

First, if third order attractors (Section I) truly force triads to adiabatically increase the diameter of their orbits when concentrations of matter occur, most pertaining fundamental constants, which have obviously been established on the assumption that the density of matter as measured at the surface of the Earth is universally constant, are inevitably approximate, and only their values determined in deep space, far from any sizable mass, could truly pretend to be universal.

Their values at any location at the surface of the Earth must be adjusted by taking into account the adiabatic expansion of the triads caused by the position of the surface of the Earth relative to the local balance of the masses that constitute it and the cyclic fluctuation of the triads masses relative to the positions of the Moon on its orbit, of the Earth on its elliptical orbit about the Sun and of the Solar system on its elliptical orbit about the galactic centre at the time of measurement.

The standard masses of the proton (1.67262158E-27 kg) and neutron (1.67492716E-27 kg), for example, are their masses as measured at the surface of the Earth. They will mandatorily turn out slightly higher when measured in deep space, far from any important masses.

Also, the depth within the gravitational gradient of the Earth where the cesium atoms emitting the frequency used to determine the length of the *second* as a universal unit of time, must be specified:
For example, the current definition of the second would be much more precisely defined if it was amended as being: *the duration of 9 192 631 770 cycles of the radiation corresponding to the transition* ***at sea level***, ***at perihelion of Earth's orbit***, ***with the Moon at its zenith***, *between the two reference hyperfine levels of the fundamental state of the cesium 133 atom*.

But the best solution for a universally constant duration of the second could be after all to choose a reference that does not vary with the local intensity of gravity. For example the frequency of the electron rest mass energy, that is 1.235589976 E20 periods per second (Hz), a universally constant frequency all over the universe, in total vacuum as well as in the centre of the most massive stars.

Since the *meter* is already defined with respect to the universally invariant speed of light, if the *second* was to be redefined with respect to the invariant frequency of the electron rest mass energy and the *kilogram* eventually redefined with respect to the invariant rest mass of the electron, all three fundamental units (second, kilogram and meter) of the SI system would finally become universally stable and invariant.

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