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The Corona Effect

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Abstract:- It can be shown that electron/positron pair production, nucleogenesis and nucleisynthesis could be much more extensive than assumed in current theories in the Sun's corona. It can also be shown that the extreme temperatures observed in the corona may be due to nucleon genesis within the corona and that most heavy elements in the Solar system could be indigenous and could have been produced in the corona by nucleisynthesis.

Keywords:- nucleogenesis, nucleisynthesis, neutron, proton, electrons, positron, corona, photosphere, chromosphere, CME, solar winds, 1.022 MeV, pair creation, planetary system, planet, Sun, star.

I. SUMMARY DESCRIPTION OF THE CORONA

The most remarkable feature of the Sun's corona is its extreme temperature, which far exceeds that of the Solar surface (the photosphere) and of its atmosphere (the chromosphere) which is located between the lower edge of the corona and the photosphere. While the temperatures of both photosphere and chromosphere remain fairly constant at ≈5800 ^{o}Kelvin (^{o}K) up to an altitude of ≈2400 km, it steeply climbs towards the 11000 ^{o}K mark within a rather narrow transition region, to abruptly jump over the 1 million ^{o}K mark at an altitude of ≈2500 km, which marks the lower edge of the corona. Let us note here that 11000 ^{o}K is the temperature of total ionization of hydrogen.

A. Unexplained Coronal temperatures in the millions ^{o}K

From this point outward within the corona, temperatures of 2 to 3 million ^{o}K are often observed with frequent way higher peaks. These million+ degrees temperatures in the corona average out at about 200 times that of the photosphere and chromosphere. This extreme average temperature in the corona is an equilibrium temperature, which means that the huge energy losses that the corona suffers through constant exchanges with the chromosphere and outward ejections of material is permanently compensated by some internal coronal process not yet understood.

This quite abrupt increase in temperature at the chromosphere-corona boundary is accompanied by an equally abrupt density decrease by many orders of magnitude that sufficiently thins out the coronal material for it to reach a state of highly energetic collisionless medium, which is the definition of a plasma.

On an 11 years cycle, the shape of the corona oscillates from being a wide crown about the Sun's equator to being a completely closed envelope surrounding the Sun.

It is assumed quite logically that the only possible cause of this million+ ^{o}K heat in the corona somehow has to be due to some process involving the Sun itself. But since none of the satisfactorily demonstrated heating models in the score that are currently being considered ([1], p. 360, Table 9.2) can account for more than about 10% of the observed coronal heat, the whole issue remaining essentially unresolved.

The reason for questioning that the actual process could directly involve the Sun, is the fact that it is impossible in view of the 2nd principle of thermodynamics that the 5800 ^{o}K heat coming from the photosphere and chromosphere could explain the 200 fold raise in temperature observed at the chromosphere-corona boundary. What is happening at the corona-chromosphere interface is as disconcerting as if we observed a pot-full of water starting to boil by putting it on block of dry ice, which is why the idea that some process internal to the corona could be at play is to be considered.

Quoting Markus Aschwanden in his excellent textbook "**Physics of the Solar Corona**": "*The physical understanding of this high temperature in the solar corona is still a fundamental problem in astrophysics, because it seems to violate the second thermodynamics law, given the much cooler photospheric boundary, which has an average temperature of T = 5785 ^{o}K*" ([1], p.26).

In relation with these extreme temperatures, all atoms present in the corona are ionized, contrary to those in the chromosphere, which means that all hydrogen atoms are fully ionized in the corona since each of them has only one electron to be shed. The energy of the free moving electrons in the corona is so great that permanent capture by positive ions becomes practically impossible.

B. Hundreds of billions of tons of material expelled each day

The corona is a highly fluctuating and inhomogeneous medium, constantly being stirred up by important upflow and downflow exchanges with the chromosphere. Intense closed magnetic fluxes originating

mainly from the equatorial belt of the Sun that constantly reconfigure it, and open magnetic fluxes from the poles, cause of the solar winds, constantly expelling hundreds of billions of tons of ionized material each day from the outer edges of the corona, to migrate into the whole Solar system.

II. OVERABUNDANCE OF ELEMENTS IN THE CORONA

The variety of elements that can be found in atomic state in the corona is largely similar to that of the photosphere and general cosmic distribution as confirmed by comparing coronal spectral analysis with meteorite analysis.

C. Three fold overabundance of detected metals

One fact of particular interest is that most of the metals detected, particularly sodium, magnesium, aluminum, iron and nickel, seem to be about **3 times more abundant in the corona and solar winds** than in the Sun's photosphere ([1], p. 31, Table 1.2)! This second fact, besides the 200 fold higher temperature of the corona with respect to the photosphere and chromosphere, strengthens yet more the possibility that some process internal to the corona could be at play, not directly involving the Sun itself.

Current instruments sensitivity prevents being as affirmative for the other elements, so we do not have much data on the relative abundance of the most other elements with respect to the photosphere.

D. Two thousand fold overabundance of Helium

There is a notable and intriguing exception regarding helium however, the observed overabundance of both isotopes (He3 and He4) during coronal flares, reaches the astonishing figure of 2000 times ([48], p. 499, Table 11.3). Could such flares be a particularly favorable circumstance for nucleisynthesis of lighter elements (see further on), or do they simply allow making more obvious such a possibly general helium overabundance in the corona?

Elements with atomic numbers 31 and more cannot currently be clearly detected in the corona with current instruments. But there is no doubt that all elements of the periodic table can be found in the corona since they all are detected up to and including uranium in the photosphere with which it has constant material exchanges.

E. All stars have coronas

Elsewhere in the Universe it was found that all stars that have been examined with x-ray telescopes also have a corona, some belonging to young stars being much more active than Sun's. So, coronal activity seems to be a universal process accompanying each star.

Now that we have put in perspective the main unexplained features of the corona, that is its extreme temperature and confirmed overabundance of practically half the elements that can be detected in it (lacking sufficient data about the other elements), let us analyze these features in light of other known facts.

III. POSITRON PRODUCTION IN THE CORONA

In his excellent textbook, Aschwanden puts in perspective positron production in the corona by **β-** decay from radioactive ions as shown by Pauli in 1930 ([1], p.631, Table 14.3). But quite astonishingly, no mention whatsoever is made of the positron materialization process from photons of energy 1.022+ MeV decoupling into electron-positron pairs discovered by Blackett and Occhialini in 1933 ([5]). An analysis of the mechanics of electron-positron pair production in the 3-spaces model is carried out in a separate paper ([7]).

This very well documented process of photons of energy 1.022+ MeV easily converting to pairs of electron/positron when grazing atomic nuclei ([3], p.17), is also very well known and understood in high energy accelerator circles.

$$\gamma \rightarrow e^- + e^+ \tag{8}$$

It was also exhaustively demonstrated that positrons and electrons are totally identical, except for the sign of their charges, both particles having the exact same invariant rest mass of 9.10938188E-31 kg, or 0.511 MeV/c^2, which is exactly half the energy of the lowest energy photon that can convert to a pair of these particles.

It is well established that if a photon being converted possessed more than 1.022 MeV to start with, the energy in excess of the two quantities of 0.511 MeV/c^2 making up the rest masses of the particles, directly determines the relative velocities in opposite directions of both particles in space after materialization ([2], p. 174).

It was also experimentally confirmed in 1997 by a team led by Kirk McDonald, at the Stanford Linear Accelerator (SLAC) that electron/positron pairs can also be produced by converging concentrated beams of sufficiently energetic photons towards a single point in space, which means that these photons succeed in destabilizing each other when they are forced close enough to each other, just like they are destabilized by passing close to a heavy nucleus.

F. Abundance of 1.022+ MeV photons in the corona

Now why is this very well known and documented electron-positron genesis process not even mentioned in any paper or textbook concerning the corona, considering that photons of energy 1.022+ MeV occur as a practical continuum in the corona? This is a question that I have no answer for.

IV. HYPOTHESIS OF NUCLEON GENESIS IN THE CORONA

Before analyzing a process that could explain the million+ ^{o}K temperatures ambient in the corona, there is need to put in perspective a little documented high yield adiabatic energy induction process.

Beyond the well documented first stage process consisting in the conversion of massless photons into pairs of massive electrons-positrons, there also exists a little known and practically unexplored related second stage higher mass genesis process, the first preliminary hints of which were theorized about in the 1950's, and about which not a word is mentioned either in Aschwanden's textbook, but which is described by M. Haïssinsky, Director of Research at the C.N.R.S. in Paris in the 1950's, in his book "**La chimie nucléaire et ses applications".**

According to him, it had been theoretically demonstrated that metastable combinations of 2 positrons + 1 electron, or alternately 2 electrons + 1 positron show some stability, but that it is much less than that of positronium, and that no experimental verification had been carried out at the date of publication to explore what happens when acceleration kicks in ([3] , p. 33).

Theoretically, this process could involve the following relations:

$$e^- + 2e^+ \rightarrow p + 3\gamma \rightarrow p + n\pi^o + n\pi^{\pm} \quad (9)$$

and

$$2e^- + e^+ \rightarrow n + 3\gamma \rightarrow n + n\pi^o + n\pi^{\pm} \quad (10)$$

It is well established experimentally that π mesons (made up of up and down quarks, which are marginally more massive than electrons) can routinely be created from head-on collisions of two beams of electrons and positrons ([4]) and that even way more massive baryons (protons and neutrons) also are customary byproducts of such head-on scattering of beams of way less massive electrons and positrons ([6]).

It was routinely observed and extensively studied in high energy accelerators that when beams of electrons and positrons are collided head on with sufficient energy, a variety of particles more massive than the colliding electrons and positrons systematically materialize as a function of the quantity of energy liberated during such scattering events, including protons and neutrons.

The following set is mentioned as more specifically observed:

$$2e^- + \text{Kinetic Energy} \rightarrow p + 4e^- + 2e^+ + n\pi^o + n\pi^{\pm} + \text{other particles} \quad (11)$$

These experimental observations will be discussed more deeply further on.

A complete analysis of the mechanics of neutron and proton production in the 3-spaces model from triads of electrons and positrons is carried out in a separate paper ([8]). This process can be summarized as follows:

Considering the presence of 2 electrons plus 1 positron thermal enough and close enough to each other to meta-stabilize into a closed system before inevitably decaying (that is, starting to adiabatically accelerate inwards towards their center of mass), we observe that we are dealing with two electrons that repel each other while both are simultaneously being attracted to the same single positron.

For such metastable triads to form, the particles have to be in very low thermal state, which leaves them with not enough energy to escape from each other after initial mutual metastable capture, a metastable system deemed to decay even faster than positronium, according to Haïssinsky's description.

Extensive experiments with positronium, a metastable system made up of an electron-positron pair forced into a volume smaller in diameter than $2.116708996E10^{-10}$ meter ([9], p.323) with insufficient energy to escape mutual capture, shows that positronium eventually decays by dematerializing into 2 or 3 photons whose sum of energies carry away the total amount of energy that made up the masses of both initial particles. Conversion of such pairs into single 1.022 MeV photons has even been observed ([8], Section B).

But when 2 thermal electrons and 1 thermal positron are captured in such a common low energy system as described by Haïssinsky, they find themselves in a unique situation since all three particles are elementary, which means that none of them can be split to then form two pairs that could join as positronium double-particle systems that could then decay into massless photons.

Of course, as decay proceeds in their attempt to join anyway, the particles will adiabatically accelerate as they start translating about their common center of mass, the two electrons will obviously repel each other more and more strongly as they get closer while being simultaneously more and more strongly attracted to the single positron. In the 3-spaces model, the end result of this process is the production of neutron plus three high energy photons.

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 the energy drift toward magnetic state, an energy drift due to the very tight closed orbit that they are 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 constraining electromagnetic environment of the nucleon structure during such destructive scattering events, the electrons and positrons involved would immediately recover their full unrestricted unit charge and usual rest mass!

The detailed description of this possible mechanics of nucleon genesis (nucleogenesis) by adiabatic acceleration of electrons and positrons far exceeds the scope of the present paper, but is fully exposed in a separate paper with complete theoretical support ([8]). Similarly, the magnetic drift responsible for the diminished electric charges of elementary particles forced into closed orbits is analyzed in another separate paper ([11]).

As a final step of this adiabatic acceleration process, leading to nucleon production from such triads, a final stable state is reached, at which point the three particles display slightly increased masses and diminished charges, where it becomes impossible for the particles (2 electrons "now down quarks" and 1 positron "now up quark") to approach any closer due to the magnetic repulsion between the various components in motion, a repulsion ending up exactly counterbalancing the electrostatic attraction. This equilibrium state is described in separate paper ([2]).

The analysis shows that as the three particles stabilize at a translation radius of the order of 1.2E-15 m, an energy of about 310 MeV is continuously being induced for each quark of the triad. This means that when that final state of the shrinking triad formation is reached, three extremely energetic bremmsstrahlung photons of about 155 MeV each have to be emitted to evacuate the energy accumulated during the adiabatic acceleration process in excess of the amount required at the final rest state distance ([8], Section VII and VIII), most probably immediately converting to $\boldsymbol{\pi}$ mesons, leaving behind only the maintenance energy perpetually induced at this distance.

V. NUCLEOGENESIS BREMMSSTRAHLUNG ENERGY IN THE CORONA

Since such large quantities of 1.022+ MeV photons are constantly present in the corona, the conditions seem potentially appropriate for triads of electrons and positrons to occasionally find ideal conditions for mutual capture in systems that eventually decay to become massive quantities of protons and neutrons. The question is then what would be observed in the corona that could support such an expectation?

In a recent paper ([8], Section VIII) a thorough analysis was carried out, describing how electrostatic acceleration at the fundamental particles level induces extra energy when an electron is captured for the first time by a proton after it was created by pair production from the conversion of a 1.022 MeV photon, a process that does not violate the Principle of conservation of energy, given that this first acceleration after creation of the electron is an irreversible adiabatic process ([8], Section VI).

Similarly, when 2 electrons plus 1 positron mutually capture in a metastable system and accelerate adiabatically inwards in the system for the first time of their existence to end up as a neutron, now possessing 600 times more energy than the three original particles, that is 939,56533 MeV/c^2, after having stabilized at a translation radius of 1.2E-15 m, kinetic energy of about 310 MeV has to be continuously induced for each quark of the triad.

So, quite logically, when the final state of the shrinking triad formation is reached, three extremely energetic bremmsstrahlung photons of about 155 MeV each are emitted as the positrons and electron (now up and down quarks) stabilize on their final orbits, carrying away the excess unidirectional kinetic energy that the three particles accumulated during acceleration. This makes for a total amount of 155 x 3 = 465 MeV energy being released for each nucleon thus created.

G. Nucleogenesis driven 227 fold increase in ambient energy

As already analyzed, the threesomes of electrons and positrons that will end up associating and accelerating into stabilizing as each of these nucleons can theoretically be seen as having been generated from two 1.022 MeV photons splitting into two pairs, for a total of 1.022 x 2 = 2.044 MeV initial energy.

So, on top of ending up with either one proton plus one free electron, or one neutron plus one free positron, each nucleon creation event from two 1.022 MeV photons **causes an increase in ambient energy of 465 ÷ 2.044 = 227.5 times** the energy that was present as the triad acceleration process began, which falls exactly into the energy increase range observed in the corona!

H. Quantities of nucleogenesis mesons detected in the corona

It goes without saying that all three 155 MeV photons thus produced are more than likely to immediately convert to pions, since they come into being in the immediate vicinity of the massive nucleon from which they are escaping, the apparently normal destabilization mode of such high energy photons logically being converting to the most massive transient particle that can be produced, they most certainly will immediately convert to $\boldsymbol{\pi}$ mesons.

Any one of the following combinations is likely to be stochastically produced with each nucleon generated:

$$e^- + 2e^+ \rightarrow p + 3\gamma \rightarrow p + X \tag{12}$$

and

$$2e^- + e^+ \rightarrow n + 3\gamma \rightarrow n + X \tag{13}$$

Where X can take any one of the following values:

$$3\pi^o\ ;\ 2\pi^o + \pi^-\ ;\ 2\pi^o + \pi^+\ ;\ \pi^o + \pi^- + \pi^+\ ;\ \pi^o + 2\pi^-\ ;\ \pi^o + 2\pi^+\ ;\ 3\pi^-\ ;\ 3\pi^+\ ;\ 2\pi^- + \pi^+\ ;\ 2\pi^+ + \pi^-$$

These mesons have been observed in abundance in the corona and are known to quickly decay into final states that always turn out to be more gamma photons and electron-positron pairs, creating in the process **highly energetic electrons and positrons**, and also gamma photons most of which exceeding the 1.022 MeV decoupling threshold ([1], p. 632)!

Neutral mesons ($\boldsymbol{\pi^o}$) have an initial rest mass of 135 MeV/c^2 while charged mesons ($\boldsymbol{\pi^-}$ and $\boldsymbol{\pi^+}$) have an initial rest mass of 139 MeV/c^2. So from the 155 MeV photon that the meson is produced from, the latter carries on with the very high kinetic energy of respectively 20 MeV and 15 MeV.

I. Quantities of extra e^+ and e^- produced from mesons decay

Neutral $\boldsymbol{\pi}$ mesons are known to practically always decay into a pair of equal energy 67 MeV photons, and occasionally as a pair of electron and positron plus one photon carrying the remainder of the energy, meaning that any excess kinetic energy that the meson may have if it converts to two photons is taken up by the particle whose interaction with the meson caused its conversion to photons energy:

$$\pi^o \rightarrow 2\gamma \tag{14}$$

or

$$\pi^o \rightarrow e^- + e^+ + \gamma \tag{15}$$

On their parts, $\boldsymbol{\pi^-}$ and $\boldsymbol{\pi^+}$ charged mesons generally decay first into like-signed muons and finally into like-signed electrons or positrons plus corresponding neutrinos:

$$\pi^- \rightarrow \mu^- + \text{anti-}\nu_\mu \rightarrow e^- + \text{anti-}\nu_e \tag{16}$$

and

$$\pi^+ \rightarrow \mu^+ + \nu_\mu \rightarrow e^+ + \nu_e \tag{17}$$

This implies that if such a nucleon genesis process is frequent in the corona and possibly even was the main source of energy in the corona, sizable quantities of high energy electrons and positrons would not need to be accelerated to the high energies that are being observed, since they would come into being already displaying high to extreme levels of energy! Which of course does not preclude further acceleration by the already studied means to the even higher energies also observed ([1], p. 613).

VI. ABUNDANCE OF TRIGGERING 1.022+ MEV PHOTONS

J. Thermalization of energetic electrons and positrons

It must be very clear by now that for any threesome of electrons-positrons to mutually capture as a metastable system before accelerating to form a nucleon, they need to be thermal to start with or else they would simply scatter off each other or recombine as pairs to reconvert to a few photons if any electron links up with just one positron (the well known positronium decay process). So what is needed for very low relative energy thermal electrons and positrons to come about in the corona is a process that would cause these high velocity electrons and positrons to slow down sufficiently.

We know from observation that such slowing down of electrons in the corona is quite frequent. In fact the low energy photons detected due to free-free emission is possibly the most important observation tool in studying the corona ([1], p. 42). So this is an interesting possible source of thermal electrons.

Free-free emission is the process by which an electron loses energy as a bremmsstrahlung photon as it is deflected by a proton with too much velocity to be captured, which is the usual type of encounters in the corona, given that all atoms presents are highly ionized.

K. Creation of already thermal pairs

The best candidates however would be actual photons of energy 1.022 MeV or slightly higher energy since their decoupling would leave no excess energy for the created pair to move very far away from each other. Such a pair would then appear at a practical dead stop with respect to each other. If perchance either a thermal electron or positron happens to be near enough at this precise moment, a mixed threesome could immediately metastabilize and the inward adiabatic acceleration process would be triggered.

L. Verified creation of thermal pairs in the corona

The fact is that large amounts of photons in the 10 keV to 10 MeV photons have been observed in the corona. Every time a large flare occurs from the Sun, such photons are emitted by the chromosphere as particles are accelerated to sufficient energy to interact with atomic nuclei falling back into the denser chromosphere where a number of collisions produce gamma photons in the proper range, amounting to a continuous emission by a number of processes: electron bremmsstrahlung, nuclear de-excitation, neutron capture, positronium annihilation or pion decay radiation ([1], p. 42).

Since starting from the 1.022 MeV energy level threshold, photons are very sensitive to decouple into electron-positron pairs, there is no doubt that a large number of them grazing highly ionized atomic nuclei in the corona will actually decouple in a thermal state ready for re-combination with a relatively thermal electron or positron that would happen to be in the immediate vicinity.

So observation reveals that the well known pair production process is guaranteed to occur in the corona by the presence in the appropriate thermal state of the particles required to initiate a triad production process, thus providing an increase in ambient energy level more than 200 fold just as observed and systematic production of ultra high velocity electrons and positrons just as is also observed in the corona.

VII. NUCLEISYNTHESIS IN THE CORONA

M. Continuous nucleon genesis by low level chain reaction

The question now is: once initiated from pair productions due to free moving 1.022 MeV photons decoupling from the first large flare after a star ignites, could such a nucleon genesis process be self-maintaining in the corona? Some sort of low level non-explosive chain reaction!

From observation of the continuous existence of coronas about the Sun and other stars, it would seem so if such nucleon genesis really is the explanation of the extreme temperature observed in coronas. The actual mechanics of self-maintenance remains to be clarified, which would involve the numerous second generation high energy gamma photons being emitted during the decay process of the innumerable pions produced.

We could certainly speak of nucleisynthesis already with the creation of protons from accelerating threesomes made up of thermal electrons and positrons, since protons are hydrogen nuclei. But what about the more massive nuclei of the periodic table that can also be found in such overabundance in the corona?

N. Protons and neutrons produced in statistically equal numbers

Let us note here that statistically speaking the chances for a neutron to be created by an initial threesome acceleration process are exactly equal to those of a proton, which means that statistically equal numbers of neutrons and protons are likely to be produced if the process is repeated. What is more, all of them will be thermal by definition, practically appearing at a dead relative stop at the location of creation since the three particles that accelerate transversally to make them up have to be thermal to start with.

O. Production of all elements favored by the presence of crowds of free thermal nucleons

Since crowds of thermal protons and neutrons are likely to rather often come close together in the coronal plasma, nucleisynthesis of lighter atoms such as helium, lithium and other lighter elements would not really be surprising given the presence of so many of the required free thermal neutrons and protons. These lighter nuclei being partially if not completely ionized definitely stand a chance of converting to higher number nuclei, here again due to the presence of so many free moving neutrons, protons and other light ionized nuclei being available in the coronal plasma.

Could such nucleisynthesis be the cause for the 3-fold overabundance of these light elements noted in the corona and solar wind with respect to the Sun's photosphere? The probability is of course very high, a process that must have been going on ever since the Sun ignited, since we can assume that the corona has existed from that moment on and which must have produced countless trillions of tons of new atoms covering the complete spectrum of the periodic table of elements!

P. Experimental proof of continuous production of elements in the corona by absorption of neutrons

Now, are there identifiable signs that neutron absorption driven nuclei building does occurs in the corona? The answer is yes. Given that the bremmsstrahlung photon emitted when a neutron is captured has a very narrow characteristic value of 2.223 MeV, it is quite easy to identify it in radiation spectra. This very narrow gamma ray line is indeed often quite prominent in high energy spectra of the corona ([1], p. 629 and p.

34, Figure 1.25) meaning that considerable capture events by protons frequently occur and that neutrons are plentiful in the corona.

Neutron capture by heavier nuclei involving a wide range of bremmsstrahlung photon energies is less easily identifiable in the coronal spectra (with capture by He3 producing practically no energy) but since so many neutrons obviously are available for capture by protons, there is no doubt that they also are just as easily available for capture by larger nuclei.

Current models assume that the whole population of free neutrons observed has to be produced by destructive scattering of highly accelerated ions of carbon, nitrogen, oxygen, iron, etc., scattering highly energetic free neutrons off these nuclei, which implies that they have to first be slowed down to allow capture by protons and higher mass nuclei ([1], p. 630), but if they were produced by nucleogenesis as analyzed here, they would be plentiful in the corona already thermal enough at the very moment of production to be immediately available for capture.

VIII. THE BIRTH OF PLANETARY SYSTEMS

Q. The Solar winds

We mentioned earlier that solar winds are constantly expelling hundreds of millions of tons of ionized material from the outer edges of the corona away to migrate into the whole solar system. The material thus expelled can be sent even way beyond Pluto, as far as the heliopause, at about 100 times the distance from the Earth to the Sun, which is the frontier at which the pressure of the solar winds starts falling into equilibrium with the pressure of particles coming from interstellar space. So let's now clarify the nature of these "solar winds".

Solar winds are still being analyzed as their mechanics is not yet fully understood, but they are known to be driven by the magnetic field of the Sun. The stronger component, the fast wind, which is known to be driven by the open magnetic fluxes originating from both poles of the Sun while a weaker component (the slow wind) operates mainly from the equatorial region where magnetic fluxes are observed to be mostly closed.

The fluxes issuing from the poles are termed "open" because they are not observed to be folding back towards the Sun as any magnetic flux must do. It seems obvious however that the magnetic "lines" issuing from the north pole of the Sun have to eventually loop back to re-enter the Sun's south pole, otherwise there would be contradiction with Maxwell's equations. They most certainly loop back possibly as far as the heliopause maybe without us being able to directly verify for the moment on account of the distances involved.

R. Expulsion of 6.7 billion tons de material per hour

It has been calculated that solar winds expel a steady flow in all directions from the outskirts of the corona of about 6.7 billion tons of material per hour ([1], p. 703) at typical initial velocities varying from 1.44 to 2.88 million kilometers per hour ([1], p. 167) which means that it takes only about 150 million years for the equivalent of the total mass of the Earth to be expelled!

Textbooks and other references lead to think that it is not yet clearly understood why ionized particles being carried outward by the solar winds acquire such high ejection velocities as they reach a distance of about 5 solar radiuses from the Sun's photosphere.

But since all particles in the masses of material being carried away in the Sun's strong magnetic field are ionized, thus charged, and moving in the same direction in a practically locally parallel straight lines away from the Sun, the Lorentz law

$$F = q(E + v \times B) \tag{18}$$

mandates that a macroscopic electric field obeying the relation v=E/B has to come into being to account for all these particles moving in a straight line away from the Sun. There simply exists no possibility for charged particles to move in a straight line at any velocity whatsoever if this E/B equilibrium is not locally established, involving equal local density for both electric field (**E**) and magnetic field (**B**).

What most probably happens is that once some massive amount of ionized (thus charged) particles are forced by whatever circumstances to start moving in the same direction away from the Sun in a directed magnetic field, their individual electric charges can only add up to constitute some local macroscopic electric field at the same scale as the ambient magnetic field. See in this regard an analysis of the Einstein-de Haas and Barnett effects carried out in a separate paper ([10]).

A similar idea was already proposed by Kaoru Takakura in 1988 ([1], p. 499, sub-ref: Solar Physics Journal, No.115, p.149) involving stochastic electromagnetic wave-particle interaction processes, the acceleration occurring at the particles scale to average out at the macroscopic scale.

Such an electric field has no choice but to establish itself normal to the ambient magnetic field and also to the direction of motion of the mass of particles, since that in accordance with Maxwell and Lorentz, any charged particle moving in a straight line can do so only perpendicularly to a plane defined by a magnetic field itself perpendicular to an electric field, with both fields having equal density and whose intensity determines the velocity of the particle, being themselves perpendicular to the direction of motion of this particle. **There simply exists no other possibility**.

S. Coronal Mass Ejections (CME)

The velocity of the massive amounts of particles involved will have no choice but to adjust to the intensity of the macroscopic E/B equilibrium being established to sustain their straight line motion outwards. Such an adjustment, thus acceleration, would no doubt tend to be progressive over a measurable period of time as the global electric field grows towards this global E/B normal alignment, which is precisely what seems to have been measured regarding CMEs, which we will now discuss ([1], p. 721).

T. CMEs expel each day up to 125 times more material than solar winds

Besides the steady outflow of material due to solar winds, cataclysmic events named **Coronal Mass Ejections** (CMEs) typically occur a few times each day, sending out from 100 billion to 10 trillion tons of material each time at velocities ranging from 360 000 km/h to 7.2 million km/h ([1], p. 703). This means that on average, CMEs expel **each day** from 2 to 125 times more material than the steady daily solar wind outflow of material!

There is proven evidence that all CME processes are initiated at the outskirts of the corona just like solar winds ejections, that is, nowhere near the transition region with the Sun's chromosphere ([1], p. 731) which confirms that they are not driven by the more energetic activity of the lower corona.

If we set for CMEs a conservative average of 30 times more material ejected than the steady solar wind outflow, this means that combining both ejection processes, only 5 million years is required for the equivalent of the total mass of the Earth to be expelled outwards from the corona to spread out into the solar system! And this process has presumably been going on ever since the Sun apparently ignited an estimated 4.5 billion years ago!

U. The total mass of the whole planetary system ejected in less than 2,275 billion years

Considering that the combined mass of our planetary system, including the Kuiper belt material and other inner heliospheric materials, amounts to about 455 Earth masses, it would have taken only about 2,275 billion years for an equivalent amount of mass to have been ejected from the corona into the heliosphere!

Since coronas about younger stars have been observed to be much more energetic than ours, it seems probable that this might also have been the case for our own corona. So the time for this amount of mass to have been ejected from the corona when the Sun was still young may have been far shorter, maybe less than 500 million years. These ballpark figures are of course approximate, but most probably of the right order of magnitude.

Now what are we to make of these figures?

V. All of the matter in the planetary system could have been generated in the Corona

It has been theorized up to now that the heavier elements present in the planetary system must have been formed as supernovae exploded elsewhere in the universe and must have migrated somehow 4 billion years ago to become available to eventually make up the planets of our system.

There is little doubt that supernovae do eject countless billions of tons of all elements as they explode, but we just saw that if general nucleon genesis really occurs in the corona, rather convincing telltales for which being the million+ ^{o}K temperatures and confirmed overabundance of the metals detected in the corona with respect to the Sun's chromosphere, there exists a real possibility that all elements in the solar system could be indigenous, except for the initial hydrogen cloud that eventually condensed in an accumulation that eventually reached critical stellar ignition mass causing our Sun to become a star.

If such is the case, it is more than likely that due to their higher mass, the heavy ions formed in the corona would have tended to be expelled to lesser distances from the Sun than the lighter elements by slow CMEs and by the slow solar wind that dominates on the plane of the ecliptic.

This may very simply explain why the inner planets, Mercury, Venus, Earth, Mars and the asteroid belt, are way more dense than the outer gas giants, which on their side may generally have been the product of high velocity CMEs and fast solar wind, even in which heavier ions could possibly also have been mostly sent to lesser distances than lighter elements due to their larger masses. This would also explain why the densest planet is closest to the Sun with the others generally becoming less massive with distance.

Such a possibility would greatly simplify understanding planetary systems creation in the universe since there would be no more need to invoke the rather farfetched hypothetical creation of all heavy elements in the universe only from the after all rather rare supernova explosions option.

W. Every star can develop a planetary system

Finally, such nucleisynthesis of all elements in our corona combined to the confirmed presence of coronas accompanying all observed stars would confirm the hypothesis that all stars mandatorily eventually develop a planetary system.

Also, it is estimated that the Sun came into active star state about 4.6 billion years ago, although such a figure really is guesswork and could be highly underestimated. What we are certain of is that it is older than the Earth whose oldest rock identified today has been estimated to be over 4 billion years old. But working with this

4,6 billion years old ballpark figure would mean that from that moment on till today, the equivalent of 2 to 10 times the mass of the whole planetary system has been ejected from the corona.

Even considering the very conservative 2 times estimate, the question comes to mind as to what happened to the extra material ejected, which is the equivalent of the current mass of our planetary system, that is, 455 Earth masses?

There logically can be only one answer to this question. Just as there exists intense exchanges of material at the chromosphere-corona boundary, there must exist similar exchanges at the heliosphere-galactic boundary, possibly sending that material as far as the Oort cloud and possibly even contributing material to that heliocentric spherical accumulation of material, otherwise all of that material would still be found within the heliosphere.

This also means that all stars must have come (and still are coming) into being with no planetary system after condensing from some part of the primordial hydrogen plenum, itself possibly having begun with a few primordial high energy photons, that countless eons in the past, mutually destabilized into the first pairs that then produced the first hydrogen nucleus as they liberated the three mesons that produced the second generation photons and charged electrons and positrons that kept this irreversible process going.

Planetary systems then progressively came into being as new material was produced in coronas, and increased in mass over time while extra material was also being ejected into the galactic surroundings. This then means that the masses planetary systems and galaxies had to increase over time and that the universe has become progressively more massive over time, a process that would still be ongoing.

IX. CONCLUSIONS

If nucleon genesis was confirmed as occurring in the corona, this would provide a direct answer to the extreme temperatures issue of the corona.

If nuclei synthesis in the corona of elements more massive than hydrogen was confirmed, this would give substance to the hypothesis that all elements in the Solar system could be indigenous and that all stars eventually develop a planetary system.

REFERENCES

[1] Markus Aschwanden. **Physics of the Solar Corona,** Springer, 2006.

[2] André Michaud. **On the magnetostatic Inverse cube law and magnetic Monopoles.** International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com. Volume 7, Issue 5 (June 2013), PP.50-66. (http://www.ijerd.com/paper/vol7-issue5/H0705050066.pdf).

[3] M. Haïssinsky. **La chimie nucléaire et ses applications,** France, Masson et Cie, Éditeurs, 1957.

[4] G. Goldhaber et al, **Observation in e+ e- Annihilation of a Narrow State at 1865 MeV/c^2 Decaying to Kπ and K$\pi\pi\pi$**, Phys. Rev. Let. Vol. 37 No.5, 255 (1976).

[5] Blackett, P.M.S & Occhialini, G. (1933) **Some photographs of the tracks of penetrating radiation**, Proceedings of the Royal Society, 139, 699-724.

[6] Hanson, G, Agrams G.S. et al. (1975) **Evidence for Jet Structure in Hadron Production by e+ e- Annihilation**. Phys. Rev. Let., Vol. 35, No. 24, 1609-1612.

[7] André Michaud. **The Mechanics of Electron-Positron Pair Creation in the 3-Spaces Model**. International Journal of Engineering Research and Development, e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 6, Issue 10 (April 2013), PP. 36-49. (http://ijerd.com/paper/vol6-issue10/F06103649.pdf).

[8] André Michaud. **The Mechanics of Neutron and Proton Creation in the 3-Spaces Model**. International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN : 2278-800X, www.ijerd.com. Volume 7, Issue 9 (July 2013), PP.29-53. (http://ijerd.com/paper/vol7-issue9/E0709029053.pdf)

[9] Walter Greiner & Joachim Reinhardt, **Quantum Electrodynamics**, Second Edition, Springer Verlag New York Berlin Heidelberg, 1994.

[10] André Michaud. **On the Einstein-de Haas and Barnett Effects**. International Journal of Engineering Research and Development. e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Volume 6, Issue 12 (May 2013), PP. 07-11. (http://ijerd.com/paper/vol6-issue12/B06120711.pdf).