

The Corona Effect



The Corona Effect

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Abstract:

It can be shown that electron/positron production (electrogenesis), nucleogenesis and nucleosynthesis in the corona could be much more extensive than assumed from current theories. 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 planetary system could be indigenous to our system and could have been produced in the corona by nucleosynthesis.

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1 Summary description of the corona

The most remarkable feature of the corona is its extreme temperature which far exceeds that of the Solar surface (the photosphere) and its atmosphere (the chromosphere) located just below it. While the temperatures of both photosphere and chromosphere remain fairly constant at ≈ 5800 Kelvin up to an altitude of ≈ 2400 km, it then starts steeply climbing towards the 11000 K mark¹ in a rather narrow transition region, to abruptly jump over the 1 million K mark at an altitude of ≈ 2500 km, which marks the lower edge of the corona.

1.1 Unexplained Coronal temperatures in the millions K

From this point outwards, temperatures of 2 to 3 million 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 solar surface and chromosphere. This extreme average temperature of the corona is an equilibrium temperature, meaning that the huge energy losses that the corona sustains through constant exchanges with the chromosphere and outward ejection of material is permanently compensated by an internal coronal process that is still not 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 corona 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 a wide crown about the Sun's equator to a completely closed envelope surrounding the Sun.

It is assumed quite logically that the only possible cause of this million+ K heat in the corona

¹ 11000 K is the temperature of total ionization of hydrogen.

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somehow has to be some process involving the Sun itself. But since none of the satisfactorily demonstrated heating models in the score that are currently being proposed ([1], p. 360, Table 9.2) can account for more than about 10% of the observed coronal heat, the whole issue remains essentially unresolved.

The reason is that it is impossible in view of the 2nd principle of thermodynamics that the 5800 K heat coming from the photosphere and chromosphere could explain the 200 fold raise in temperature observed at the chromosphere-corona boundary. This would be like expecting water to start boiling by laying a pot full on dry ice at sea level.

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 $T = 5785 K$ " ([1], p.26).*

In relation with these extreme temperatures, all atoms present in the corona are ionized, contrary to 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.

1.2 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 its outer edges away to migrate into the whole solar system.

2 Overabundance of elements in the corona

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

2.1 Three fold overabundance of detected metals

One fact of particular interest to us here is that most detected metals, particularly sodium, magnesium, aluminum, iron and nickel, seem to be about **3 times more abundant in the corona and solar winds** than in the photosphere ([1], p. 31, Table 1.2)! Current instrument sensitivity prevents being as affirmative for the other elements, so we do have much data on their relative abundance status with respect to the photosphere.

2.2 Two thousand fold overabundance of Helium

There is a notably 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

nucleosynthesis circumstance for lighter elements (see further on)? Or do they simply allow noticing such a possibly general helium overabundance in the corona?

Elements with atomic number 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.

2.3 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 (we lack sufficient data about the other elements), let us analyze these features in light of other known facts.

3 Conservation of energy vs first time acceleration

Before proceeding, we must first put in perspective how acceleration induced kinetic energy can be related to the extreme heat observed in the corona, so let us put in perspective some known facts regarding emission of energy as an electromagnetic particle stabilizes on a stable orbit after freefall electrostatic acceleration.

3.1 The Principle of Conservation of Energy

In other words, let's mathematically define how kinetic energy is physically induced in a system when particles accelerate in free fall.

But doesn't the famous *Principle of conservation of energy* preclude the very possibility of energy addition from within an isolated system?

3.2 The case of particles in least action energy equilibrium systems

The answer is yes, it absolutely applies with any transformation involving matter and energy in any system having previously reached a state of least action energy equilibrium.

This is precisely the case of all isolated systems that are within our reach at the macroscopic level. For example, before an object found on the ground can be dropped to accelerate in free fall by the force of gravity, there is no other way but to introduce the energy required (coming from outside of the system made up of this body and the Earth) to elevate it at the distance above ground at which we will release it to measure its acceleration, and its energy gain towards the ground.

All calculations will show that the kinetic energy gained during acceleration is equal to the energy that had to previously be invested to lift it to the distance above the ground at which we let it go.

We are confronted with the same situation when experimenting at the atomic level. Atoms in our environment are not typically ionized in nature, and can even seldom be found in atomic

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state, being practically always associated in molecules of all sorts in various states of least action equilibrium.

To measure the acceleration of an electron towards a proton with our macroscopic tools, we must invest the energy required to chase this electron away from the proton to then measure the energy it will gain as it is again captured by the proton by electrostatic attraction.

All other cases of isolated systems easily accessible to us are of the same nature including all reversible adiabatic processes, whence the long standing axiomatic adoption of the Principle of conservation of energy as allowing no exception.

3.3 The case of initial acceleration of newly created massive particles

But it would seem that when an electron has just been created through a pair separation process from a 1.022+ MeV photon, and that this electron, free moving to start with, is then attracted for the first time of its own existence to an ionized proton, no potential energy could have accumulated through the expected process of it first having been forced away from a proton since this particular electron did not even exist before coming into being as the photon that produced it converted to a pair.

So without theorizing on the possible physical origin of the kinetic energy that this electron will gain as it irreversibly adiabatically accelerates for the first time towards a proton, it would seem that this energy really will be added to the isolated system made up of that proton and this newly created electron without any possibility that this could be a case a reconversion of potential energy that would have been accumulated previously by the electron.

In other words, it would seem that first time acceleration of a newly created particle towards its first least action rest state (a newly created electron reaching the ground state orbital of a hydrogen atom for the first time in our example) is not subject to the Principle of conservation and so cannot possibly violate it but rather answers all of the criteria of an irreversible adiabatic process.

So, once least action energy equilibrium has been reached for the first time by an electron up to a given electronic layer of a given energy intensity in an atom, the Principle of conservation will apply to this electron up to and including any electronic layer of same energy intensity for ever after.

But if later, in the course of the usual process of repeated liberations and recaptures, this electron ever happens to stabilize to an electronic layer requiring more intense energy than it ever reached even once before, then by very definition, the added energy required, which will be induced by this further irreversible adiabatic additional first time acceleration, will also not be subject to the Principle of conservation without violating it.

3.4 The case of all massive particles already existing in the universe

Let's now consider the case of all charged stable scatterable massive particles already in existence in the universe. Isn't it a given that all of these particles have not eternally been in existence but have individually come into being at one point or other in their own individual past?

Doesn't this mean also that every single one of them mandatorily had to irreversibly adiabatically accelerate for a first time after it first came into being before it could reach for the first time whatever state of least action equilibrium that happened to be available for it then?

If the answer to the last question is yes, then wouldn't this mean that application of the Principle of conservation to all cases including first acceleration after first coming into being of any massive particle amounts to assuming that all existing particles would have always existed with all of them having already reached maximum intensity least action energy equilibrium?

On top of electrons and positrons, this also concerns protons and neutrons, and consequently also up and down quarks. But before exploring more deeply the possibility of elementary particles genesis (termed electrogenesis in the case of electrons and positrons) and of nucleon genesis (nucleogenesis) as well as of nuclei synthesis (nucleosynthesis) in the corona, let us completely clarify the mechanics of acceleration, which is of course the same for first time acceleration and Principle of conservation subjected acceleration.

4 Defining Acceleration

What better way to clarify such an issue but to give a practical example, which also applies to all possible cases of freefall acceleration, whether or not it involves a first time acceleration, electrostatic attraction between elementary particles being known to induce this type of acceleration.

Let's consider a free electron that just appeared by production of an electron/positron pair from a photon and that is being attracted for the first time by a proton to form a hydrogen atom. It is well documented that a photon of energy 13.6 eV is emitted as the electron settles to the ground state (if we consider the Bohr atom), an orbit whose radius corresponds besides, to a constantly induced energy of 27.2 eV, which is twice the energy of the escaping photon:

$$E = \frac{1}{4\pi\epsilon_0} \frac{e^2}{a_0} = 4.359743805 \text{ E-18 J} \quad \text{that is } (27.2 \text{ eV}) \quad (1)$$

Note that this 13.6 eV amount is a quantity of kinetic energy expelled as a photon when a “free” electron has presumably accelerated from an infinite distance to be captured at a distance $a_0 = 5.291772083 \text{ E-11 m}$ from a proton. This energy can thus be calculated by integrating all of the kinetic energy that accumulates as the electron accelerates towards the proton due to the electrostatic attraction, including the part of this kinetic energy that converts to relativistic mass. The general formula for this relation is, in agreement with Leibnitz :

$$\int_{r)0}^{\infty} F \cdot dr, \quad \text{the Coulomb force equation being} \quad F = k \frac{e^2}{r^2} \quad (2)$$

Let us apply this general equation to the Coulomb equation for electrostatic force and calculate the total quantity of kinetic energy including the energy that progressively converts to relativistic mass that the electron accumulated before finally arriving at the Bohr orbit.

$$E = \int_{a_0}^{\infty} \frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2} \cdot dr = 0 - \frac{1}{4\pi\epsilon_0} \frac{e^2}{a_0} = -4.359743805 \text{ E-18 J} \quad (3)$$

We note here that 4.359743805 E-18 Joules corresponds to 27.2 eV, and not to 13.6 eV, that is, double the energy that is liberated as a bremsstrahlung photon escaping in physical reality as the electron stabilizes on its mean rest orbital about the proton. Why? Why is there this difference?

On the other hand, it is well verified that half the energy that a massive particle accumulates in excess of the energy of its rest mass systematically converts to additional momentary relativistic

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mass, an additional momentary electromagnetic mass that depends entirely on the total additional amount of energy that the particles momentarily has and that in turn depends uniquely on the instantaneous local electromagnetic equilibrium, which is determined exclusively by the sum of all of the individual energy quanta induced as a function of the various distances between this particle and all other charged particles in existence ([3], Section 7.3).

It is well established that whatever the distance between 2 charged particles, the electrostatic force induces, in other words « adds » by a mechanism not yet understood, an amount of unidirectional kinetic energy specific to this distance between the particles plus a corresponding increment of additional momentary relativistic mass, which depends on the total electromagnetic mass of the particle at this distance, that is, its rest mass plus the added instantaneous relativistic mass, and this, independently of the amount of unidirectional kinetic energy and momentary relativistic mass already accumulated.

So let's see what amount of energy will have been induced when the electron finally reaches the Bohr orbit. Given that the amount of kinetic energy required by the force for the electron to remain at this distance of the proton is determined by the total electromagnetic mass that the electron will have at this distance, and that this total electromagnetic mass was, at an infinitesimal distance before arriving at this orbit:

$$m = m_0 + \frac{E_{(a_0 - dr)}}{2c^2} \quad (4)$$

it will be at distance a_0 :

$$m = m_0 + \frac{E_{(a_0 - dr)}}{2c^2} + \frac{E_{(dr)}}{2c^2} \quad (5)$$

the total electromagnetic mass of the electron will thus increase by induction by the following infinitesimal quantity, which is the final momentary relativistic mass increment

$$\frac{E_{(dr)}}{2c^2} \quad (6)$$

that will render $E/2$ (that is, the total amount of induced energy that will have converted to relativistic mass since the beginning of the acceleration) exactly equal to 13.6 eV, which means that the amount of corresponding unidirectional⁴⁵ kinetic energy that will have been accumulated by acceleration at the moment of arrival at the Bohr orbit will of course be:

$$K = \frac{1}{4\pi \epsilon_0} \frac{e^2}{2a_0} = 2.17987190 \ 3 \ E - 18 \ J \quad (7)$$

which corresponds very precisely to 13.6 eV of unidirectional kinetic energy added by acceleration.

It can easily be verified that the mass calculated with equation (5) is exactly equal to the relativistic mass of an electron moving at relativistic velocity 2187647.561 m/s which is the relativistic velocity associated with the moving electron in the hydrogen atom ground state.

So let's summarize. Equation (5) reveals that half the energy of 27.2 eV calculated with equation (3), that integrates all of the energy induced from an infinite distance down to the Bohr

orbit, is in reality converted to added relativistic mass, which is why only half of this energy accumulated by acceleration remains in the form of unidirectionally directed kinetic energy sustaining the motion of the associated mass.

So, at the precise moment of arrival of the electron at the Bohr ground orbit, we now have a total of 13.6 eV converted to relativistic mass, plus 27.2 eV of added unidirectionally directed kinetic energy, the latter quantity being made up of the remaining 13.6 eV not converted to mass coming from the acceleration down to the Bohr orbit and an additional 13.6 eV directly induced at the moment of arrival at the Bohr orbit to complement the 13.6 eV already converted to momentary relativistic mass.

Given that the energy allowed by the electrostatic force at the Bohr orbit can under no circumstance exceed 27.2 eV if the electron is to remain at this distance (13.6 eV as added relativistic mass and 13.6 eV as unidirectional kinetic energy), we now obviously have an excess of unidirectional kinetic energy of 13.6 eV that must separate from the electron when it reaches the Bohr orbit, or else the electron would remain way too excited and would have no choice but to rebound to escape from the proton.

This is the reason why a 13.6 eV bremsstrahlung photon has to escape when a free electron is captured by a proton, which involves an abrupt slowing down to stabilize at a mean distance of a_0 from the hydrogen nucleus.

5 Positron production in the corona

In his excellent textbook, Aschwanden puts in perspective positron production in the corona by beta-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 positron materialization due to photons of energy 1.022+ MeV that numerous experimentalists, from Blackett and Occhiolini, Anderson, Irène Curie, Joliot, Chadwick, etc, in the early 1930's have experimentally confirmed from detection of such materialization from cosmic radiation.

This very well documented process of photons of energy 1.022+ MeV easily converting into pairs of electron/positron when they pass close to an atom's nucleus ([8], p.17), is also very well known and understood in high energy accelerator circles.

$$\gamma \rightarrow e^- + e^+ \quad (8)$$

It was also exhaustively demonstrated that these positrons and electrons are totally identical, except for the sign of their charge, 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 the 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 be produced by converging concentrated beams of sufficiently energetic photons towards a single point in space, which means that with the right conditions, these photons succeed in destabilizing each other when they

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are forced close enough to each other, just like they destabilize by passing close to a heavy nucleus.

5.1 Abundance of 1.022+ MeV photons in the corona

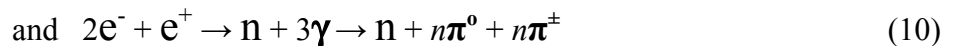
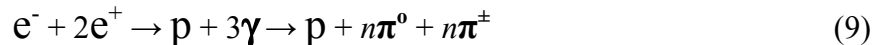
Now why is this very well known and documented process electrogenesis not even mentioned in any paper or textbook concerning the corona considering that photons of energy 1.022 MeV and higher occur as a practical continuum in the corona is a question I have no answer for.

6 Hypothesis of nucleon genesis in the corona

Another less well known but related second stage genesis process, possibly leading to understanding the mechanics of creation of protons and/or neutrons, that was theorized about in the 1950's, about which not a word is mentioned either in Aschwanden's textbook, but is described by M. Haïssinsky, then Director of Research at the C.N.R.S. in Paris, in his book "**La chimie nucléaire et ses applications**".

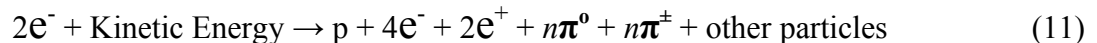
According to him, it had been theoretically demonstrated that metastable combinations of 2 positrons + 1 electron, or alternately 2 electrons + 1 positron show some stability, but that it is much less than that of positronium, and that no experimental verification had been carried out at the date of publication (1957) ([8], p. 33) to explore what happened when acceleration kicked in.

Theoretically, this can only involve the following relations:



It is well established experimentally that π mesons (made up of quarks up and down) can routinely be created from head on collisions of electron beams ([10]), but it was also mentioned by physicists on the **sci.physics** newsgroup that a similar phenomenon, but this one involving the generation of protons had also been observed, that quite strongly support the possible validity of the second stage generation process that Haïssinsky's description suggests.

It was apparently repeatedly observed in accelerators that when beams of electrons are collided head-on with sufficient energy, a variety of particles materialize as a function of the quantity of energy liberated during such scattering events, but with the following set being mentioned as more specifically observed:



We will discuss later these experimental observations.

Considering the presence of 2 electrons plus 1 positron thermal enough and close enough together to metastabilize into a closed system before inevitably decaying (that is, starting to accelerate inwards), 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, implying that they would not have enough energy to escape from each other after initial mutual metastable capture, a metastable system that is deemed to decay even faster than positronium.

But we are faced with a very special problem when 2 thermal electrons and 1 thermal positron

are captured in such a common system. We are dealing here with 3 particles instead of 2 Dirac-complementary particles, none of which can be split or be forced to convert to energy at such a low energy level.

Of course, as decay proceeds and the particles 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 to each other while simultaneously being more and more strongly attracted to the single positron.

The complete description of the possible mechanics of nucleon genesis by acceleration exceeds by far the scope of the present paper, but such a possible complete process is fully exposed in a separate text with complete supporting theoretical backing ([3]). But summarily put, it is demonstrated that the three particles must end up translating about two axes normal to each other, one named the coplanar axis, which is parallel to the plane determined by the three accelerating particles and the other simply named the normal axis.

As a final step of this acceleration process, a final stable state is reached, at which the three particles display slightly increased masses and diminished charges (we will address the charge issue shortly) and 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 ending up exactly counterbalancing the electrostatic attraction. This equilibrium state is described in a separate paper ([4], starting at Section II).

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 of the quarks of the triad. This means that when that final state of the shrinking triad formation is reached, three extremely energetic bremsstrahlung photons of about 155 MeV each will have to be emitted to evacuate the excess energy induced during the acceleration process, most probably immediately converting to π mesons, leaving behind only the maintenance energy perpetually induced at this distance.

It is shown that the rest masses of protons and neutrons is mostly relativistic with the actual masses of up and down quarks being only marginally higher than that of the electron (see below), being made up mostly of the kinetic energy induced at the minute translation radii that determine the actual volumes of protons and neutrons and that cause the quarks to circle at near light speed.

7 The issue of fractional charges

Of course, this logic implies that up and down quarks would simply be hyper-accelerated positrons and electrons. So, how could this be reconciled with the fact that up quarks have a charge of only $2/3$ that of a positron, and down quarks have a charge of only $1/3$ that of an electron ?

It must be said here that the charge of particles is probably the deepest mystery of fundamental physics. Despite a century of experimentation and reflection, we are still down to the level of pure speculation as to its nature.

What is known with certainty is that the only possible charge for a charged particle moving freely is that of the electron, or of its converse, that of the positron. As to fractional charges, they cannot be dissociated from quarks and can be observed only within the confines of complex particles made up of quarks since all attempts made to scatter them out of nucleons have seemingly failed.

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Or have they!

If up quarks simply were hyper-accelerated positrons, and down quarks hyper-accelerated electrons, what could prevent them from simply re-manifesting the unitary charge of the electron or positron at the very moment of their liberation from the confines of nucleons?

There is an apparently unrelated fact, well understood in high energy accelerator circles that may really apply here. It is the fact that to force a charged particle to move on a closed orbit, which really is the case for quarks up and down within nucleons, it is mandatory that a local magnetic field be established that will be more energetic than the related electric field ([5]).

It is entirely conceivable that when charged particles are forced by natural forces to move on closed orbits that their local magnetic field will have to become more energetic than their electric field, some energy from their electric field drifting under the stress to reinforce the local magnetic field thus weakening the electric field. This magnetic drift effect is analyzed in a separate paper ([7]).

So it is entirely possible that the fractional charges of quarks could be caused by the stress that the particles' energy fields would impose on each other due to the high intensity force imposed on them as the triad closes in until it stabilizes into its final geometry. The presence of this local stress could cleanly explain why fractional charge elementary partons have never been detected in high energy nucleon destructive scattering experiments since as a quark is scattered off, the stress imposed by the structure would then of course instantaneously disappear and normal unit charge just as instantaneously resumes for that "parton".

So a "stress factor" may need to be introduced in any dynamic field equation meant to describe either quark up or quark down that would account for the observed decrease of the electric field energy of these particles, a decrease that must be coupled with a reciprocal increase of their magnetic field energy if the equation is to remain coherent.

The manner in which this electromagnetic equilibrium principle applies to localized particles moving in straight line is described in a separate paper ([6]) and the manner in which it applies to particles moving on closed orbits is described in a different paper ([7]).

The best estimate of effective masses currently associated to up quarks lies with relative certainty between 1 and 5 MeV/c², while the best estimate of effective mass currently associated with down quarks in the Standard Model lies with relative certainty between 3 and 9 MeV/c² ([9],p.382).

Here are some values that this model provides:

	Up Quark	Down Quark
Quarks rest energy	1.149747531 MeV	4.598990173 MeV
Quarks masses in kg m=E•1.6E-19 /c²	2.049610923E-30 kg	8.198443779E-30 kg

For complete analysis of the space geometry required and description of the mechanics of nucleon genesis, the interested reader is referred to the complete text ([3]).

8 Nucleon genesis bremsstrahlung energy in the corona

Since such large quantities of 1.022+ MeV photons are constantly present in the corona, the conditions seem then well established for triads made up of electrons and positrons leading to their acceleration to become massive quantities of protons and neutrons according to the mechanics analyzed up to this point. The question is then what would be observed in the corona that would support such an expectation?

We just analyzed in **Section 4 Defining acceleration** how electrostatic acceleration at the fundamental particles level can induce extra energy when an electron is captured for the first time by a proton and that similarly, when 2 positrons plus 1 electron mutually captured in a metastable system and accelerate inwards to end up as a neutron, now possessing 600 times more energy than the three original particles, that is 939,56533 MeV/c², 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 of the quarks of the triad.

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

As already analyzed, each initial thermal electrons and positrons threesome that will end up associating to accelerate into stabilizing as each of these nucleons; electrons and positrons that were generated from the splitting of two 1.022 MeV photons splitting into two pairs of electron-positron as they graze massive particles. This makes for a total of 1.022 x 2 = 2.044 MeV initial energy.

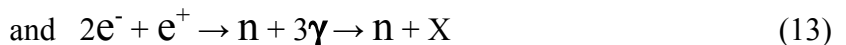
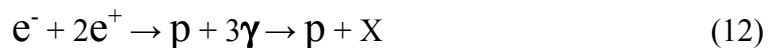
8.1 Nucleogenesis driven 227 fold increase in ambient energy

So overall, 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 the initial 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 acceleration process initiated, which falls exactly into the energy increase range observed in the corona!

8.2 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 the most transient massive particle that can be produced, they will most certainly will immediately convert to π mesons.

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



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Where X can take any one of the following values:

$$3\pi^0 ; 2\pi^0 + \pi^- ; 2\pi^0 + \pi^+ ; \pi^0 + \pi^- + \pi^+ ; \pi^0 + 2\pi^- ; \pi^0 + 2\pi^+ ; 3\pi^- ; 3\pi^+ ; 2\pi^- + \pi^+ ; 2\pi^+ + \pi^-$$

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 threshold ([1], p. 632)!

Neutral mesons (π^0) have an initial rest mass of 135 MeV/c² while charged mesons (π^- and π^+) have an initial rest mass of 139 MeV/c². 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.

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

Neutral π 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:

$$\pi^0 \rightarrow 2\gamma \quad (14)$$

$$\text{or } \pi^0 \rightarrow e^- + e^+ + \gamma \quad (15)$$

On their parts, π^- and π^+ charged mesons generally decay first into a like signed muon and finally into a like signed electron/positron plus corresponding neutrinos:

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

$$\text{and } \pi^+ \rightarrow \mu^+ + \nu_\mu \rightarrow e^+ + \nu_e \quad (17)$$

This implies that if such a nucleon genesis process is frequent in the corona and possibly even the main source of energy in the corona, sizable quantities of high energy electrons and positrons would not need to be accelerated to these high energies, 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).

9 Abundance of Triggering 1.022+ MeV photons

9.1 Thermalization of energetic electrons and positrons

We clearly understand now that for any threesome of electron-positron 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 (well known positronium decay). So what is needed for very low relative energy thermal electrons and positrons to come about 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 emission² is possibly the most important observation tool in studying the corona ([1], p. 42). So this is an interesting possible source of thermal electrons.

9.2 Creation of already thermal pairs

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

9.3 Verified creation of thermal pairs in the corona

Now have 1.022+ MeV photons been observed in the corona? The answer is YES. Every time a large flare occurs from the Sun, large amounts of photons in the 10 keV to 10 MeV photons are emitted by the chromosphere as particles that are accelerated to sufficient energy to interact with atomic nuclei fall 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 bremsstrahlung, nuclear de-excitation, neutron capture, positron 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 that graze high ionized atomic nuclei in the corona will actually decouple in a thermal state ready for combination with a relatively thermal electron or positron that would happen to be in the immediate vicinity.

So this model reveals a pair production process in the corona that guarantees the presence in thermal state of the particles required in this model to initiate a triad production process that provides an increase in ambient energy level more than 200 fold just as is observed and systematic production of ultra high velocity electrons and positrons just as is observed in the corona.

10 Nucleosynthesis in the corona

10.1 Continuous nucleon genesis by low level chain reaction

We will see in soon to be published paper how extreme adiabatic compression of hydrogen electron orbital in the center of proto-star masses forces its carrying energy (carrier-photon) to eventually reach the 1.022 MeV decoupling threshold at the center of protostars, that initiates a massive electrogenesis pair production which in turn triggers star ignition and maintains it afterwards by feeding a high yield chain nucleogenesis and fusion reaction.

² Free-free emission is the process by which an electron loses energy as a bremsstrahlung 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.

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In the corona however, we are not dealing with captive electrons carrier-photons but with free moving photons and no steady adiabatic compression process can be at play either, barring intermittent shock wave processes. 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? 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 was the explanation of the high temperature of coronas. The actual mechanics of self-maintenance remains to be clarified which no doubt involves the numerous second generation high energy gamma photons emitted by the decay of the innumerable pions produced.

We could certainly speak of nucleosynthesis already with the creation of protons from accelerating threesomes made up of thermal electrons and positrons since protons are in fact hydrogen nuclei. But what about more massive nuclei in the periodic table?

10.2 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.

10.3 Production of all elements favored by the presense 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, nucleogenesis 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. These lighter nuclei being totally if not completely ionized definitely stand a chance of converting to higher number nuclei 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 nucleosynthesis be the cause for the 3 fold overabundance noted in the corona and solar wind with respect to the 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 that must have produced countless trillions of tons of new atoms covering the complete spectrum of the periodic table of elements!

10.4 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 bremsstrahlung photon emitted when a neutron is captured has a very narrow characteristic value of 2.223 MeV, it is quite easy to identify in radiation spectra. This very narrow gamma ray line is 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 involves a range of bremsstrahlung photon energies less easily identifiable in solar corona 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 off these nuclei highly energetic free neutrons, 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 nucleon genesis as analyzed here, they would be plentiful in the corona and already be thermal enough at the very moment of production to be immediately available for capture.

11 The birth of planetary systems

11.1 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) is 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.

11.2 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 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 about 150 million years for the equivalent 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 photosphere.

But since all particles in the masses of material being carried away in the Sun's strong

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magnetic field are ionized, thus charged, and moving in the same direction in a practical straight line away from the Sun, the Lorentz law

$$F = q(E + v \times B) \quad (18)$$

mandates that a macroscopic electric field obeying the relation $v=E/B$ comes into being to account for all these particles moving in a straight line away from the Sun. There simply exists no way that charged particles could move in a straight line at any velocity whatsoever if this E/B equilibrium is not locally established.

What probably happens is that once some massive amount of ionized (thus charged) particles are forced by whatever circumstance to start moving in the same direction 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.

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 from 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, both of these fields, whose intensity determine the velocity of the particle, being themselves perpendicular to the direction of motion of this particle. **There simply exists no other possibility.**

11.3 Coronal Mass Ejections (CME)

The velocity of the massive amount 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 has been directly measured regarding CMEs that we will now discuss ([1], p. 721).

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

Besides the steady outflow of material due to solar winds, cataclysmic events named coronal mass ejections (CME) that typically occur a few times each day send out from 100 billion to 10 trillion tons of material each time at velocities ranging from 360 thousand 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 solar wind outflow of material!

There is proven evidence that all processes of CME initiate at the outskirts of the corona just like solar winds ejection and nowhere near the transition region with the 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 in the solar system! And this has presumably been going on ever since the Sun apparently ignited an estimated 4.5 billion years!

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

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

Since the 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 that 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 billion years. These ballpark figures are of course approximate, but most probably of the right order of magnitude.

Now what are we to make out of these figures?

11.6 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 no 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 happens in the corona, rather convincing telltales for which being the million+ K temperature and confirmed overabundance of the metals detected in the corona with respect to the chromosphere, there exists a real possibility that all elements in the solar system except the initial hydrogen cloud that eventually condensed to form the Sun may be indigenous.

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 massive than the outer gas giants, that 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 that the densest planet is closest to the Sun with the other 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 rather rare after all supernova explosions option.

11.7 Every star can develop a planetary system

Finally, such nucleosynthesis of all elements in the Solar 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

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certain of is that it is older than the Earth whose oldest rock identified today has been dated to 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, that 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 contribute 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 pair that then produced the first hydrogen nucleus as it liberated the three mesons that produced the second generation photons and charged electrons and positrons that kept the 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 surrounding. 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.

12 The Corona drive

We mentioned earlier that at least some protons creation seem to have been observed from high energy head on collisions of electron beams, but these occurrences seem not to really have been specifically studied.

We also saw a distinct possibility that the same type of nucleon genesis could possibly be the ultimate cause of the extreme temperatures and elements overabundance in the corona and solar winds through a process of slow non-explosive chain reaction.

12.1 Could we control a nucleogenesis chain reaction?

It is not difficult to imagine what could become possible if we became able to consistently manufacture protons and neutrons from pairs generated from the decoupling of simple 1.022 MeV photons as this model clearly hints at the possibility, which amounts to manufacturing matter from energy, instead of painstakingly extracting energy from matter as has been attempted up to now.

To put it bluntly, and not even talking of the 227 fold increase in free energy that results from each nucleon creation, controlling such conversions as a first stage, of two 1.022 MeV photons into 2.044 MeV/c² of mass (two electron-positron pairs), and then as a second stage, converting these 2 MeV/c² of mass to about 938 MeV/c² 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.

12.2 Reaction mass production with 47000% efficiency

This represents 47,000 % efficiency instead of less than 100 % for the most efficient methods available up to now. In other words, it would provide us with an inexhaustible supply of reaction-mass, and this, not even counting the three highly energetic mesons that would be created in the process.

It would become possible, among other things, to stop ravaging our planet's natural resources to supply cities and factories with energy, and even electricity producing nuclear facilities would become obsolete, to be replaced by facilities producing electricity from this new mass production process from photons.

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 energy just about 1.022 MeV, so that the decoupling pairs would have insufficient energy to really escape while being produced in sufficiently high concentrations and proximity for the triads to have a chance to form.

12.3 Free Electron Lasers (FEL) and Free Proton Lasers (FPL)

Interestingly, the technology already exists to implement the first stage of this two stages process! The 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 bremsstrahlung photons being produced can be finely tuned over a relatively wide range, theoretically up to the frequencies required for eventual pair production when directed at appropriate target material. Or maybe should we have to wait for **Free Proton Lasers** to reach the extreme gamma frequencies needed. The future will tell.

Presently, a whole range of possibilities remains to be explored, from bombarding a precise point in space with the appropriate frequency of photons to produce a sufficient quantity of pairs, to using more energetic photons producing pairs that would then have to be slowed down to allow the triads to come into being.

It would be possible to focus coherent beams of 1.022 MeV allowing high density decoupling of electron-positron pairs with minimal escape velocities that could possibly allow high density triad generation. Such a production, when well controlled, will put at our disposal unlimited amounts of reaction-mass, that is, energy.

One could even see here a possible solution to controlled fusion since neutrons, which are a mandatory ingredient of the process, statistically constitute half of the nucleons being generated during such triad production processes.

13 The neutron engine

There exists however another possibly simpler method for directly obtaining quantities of thermal neutrons by nucleogenesis. One that involves the direct conversion of an electron's carrier-photon into an immediately thermal pair of electron and positron that will instantly combine with the carried electron to form a neutron, releasing in the process the three highly energetic gamma photons whose subsequent conversion we just analyzed ([3], Sections 21.4.2 and 21.4.3).

This is in fact a process equivalent ([3], Section 28.2) to that which triggers the ignition of protostars that have reached critical ignition mass when adiabatic compression of the electronic orbitals of hydrogen atoms at the center of such masses forces the carrier-photons of the electrons of these atoms to reach the critical decoupling 1.022 MeV threshold ([3], Section 28.5).

Technically, this nucleogenesis process, which involves directly accelerating electrons with laser pulses so that their carrier-photons reach the decoupling threshold of 1.022 MeV seems much easier to obtain and control than the one involving generating bremsstrahlung 1.022 MeV photons with Free Electron Laser (FEL) since the process requires much less elaborate equipment that would be easier to reduce to volumes compatible with the motorization of spacecrafts.

Already in 2009, 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 ([11]).

This means that the day is not far when the magical 1.022 MeV level will be reached and that the unexpected flood of energy that will result will strike with wonder all those who will be witness to the event, a source of energy available in unlimited quantities when completely controlled, just like free photons thermal decoupling as analyzed in the previous section!

14 High energy constant propulsion spaceships

Regarding space exploration, it becomes possible to envision propulsion systems fueled by such photons, some sort of corona or neutron Drive, which would eject matter fundamentally created from pure energy in such huge quantities that constant acceleration at 1g would 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 reached.

13 Conclusion

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

If nucleosynthesis 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.

If sustained nucleon genesis by means of free electron lasers or free proton lasers is achieved, this would provide us with an hitherto unsuspected and unlimited controllable source of energy.

Finally, this would allow the development of a spaceship drive that could provide constantly powered space travel with no need to carry any large reservoir of propellant instead of the limited

inertial space travel that we must currently be content with, even allowing permanent acceleration that would give a modicum of artificial gravity to the crew.

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