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The Nature of the Electron

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Abstract- Unity is defined as matter or a system with its maximum energy limit. In an atom unity, electrons are attracting while energy sharing. Out of the unity, electrons are kinetically repelling while excess-energy releasing gradually. The concept of a specific “electric charge” is a misconception, also is the concept of “oppositely charged” electrons and protons. Matter’s energy is scalar, not vector, any “antimatter” is a misconception, including the concept of a “positively charged electron”, and the idea of “annihilation”. The Big Bang created four base particles: proton (p), electron (e), neutrino (ν), and photon (γ). The electron usually shares energy with a photon as an electron unity (eγ). Electrons move to be dynamic unity, expressed as two distinct types of oscillations: 1) Electrons of an atom unity oscillate around their nucleus, attracting while energy sharing. Each electron’s orbit is the equilibrium of its unity force; 2) Outside electric forces can break free those outermost electrons from the atom unities of a conductor, oscillate them away, align and energize them, forming stronger electron waves with magnetic effects, and simultaneously cause them to flow along the potential difference as electric currents.

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The Nature of the Electron

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Keywords: electron, mass, energy, unity, unity force, energy sharing, excess-energy releasing, nuclear fusion, beta decay, nuclear fission, electromagnetism, electricity, chemistry.

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I. Introduction

The electron was discovered in 1897 by physicist J.J. Thomson[1]when studying cathode rays, which he initially called corpuscles.

According to current knowledge[1], the electron is a subatomic particle with a negative electric charge, circling an atom's central nucleus formed by positively charged protons and electrically neutral particles called neutrons. This circling is called orbitals that can change (quantum leap) with energy change of the electrons, that in turn cause photon absorptions or emissions.

The electron is an elementary particle[1], without known components or substructure, belonging to the lepton particle family, having an intrinsic angular momentum (spin) of a half-integer value. The rest mass of the electron is 9.11×10^{-31} kg, which is only 1/1,836 the mass of a proton.

Electrons play an essential role in numerous physical phenomena[2], such as electricity, magnetism, chemistry, and thermal conductivity; they also participate in electromagnetic, and weak interactions. Since an electron has charge, it has a surrounding electric field that generates a magnetic field. Electrons radiate or absorb energy in the form of photons when they are accelerated.

Electrons are involved in many applications[2], such as frictional charging, electrolysis, electrochemistry, battery technologies, electronics, welding, cathode-ray tubes, photoelectricity, photovoltaic solar panels.

Chemistry and nuclear physics involve electrons interacting with other subatomic particles[2]. The exchange or sharing of the electrons between two or more atoms is the main cause of chemical bonding. Coulomb's law calculates the amount of force between two electrically charged particles at rest.

But the electron has not been fully and correctly understood. Certain misconceptions (see later sections) have been prevalent since its discovery. Therefore, the nature of the electron needs a more profound and distinct perspective, from the fundamental principles of matter and the origin of the electron, as follows.

II. The Principles of Matter – The Laws of Unity

Here are the Principles of Matter or the Laws of Unity, updated from my original version[3,4]:

1. Matter is any substance that has mass and energy. Matter's energy is scalar, not vector.
2. Energy limit (potential energy Ep) is matter's maximum energy limit in its situation.
3. Excess-energy (kinetic energy Ee) is the energy that is over the energy limit.
4. Unity is matter or a system with its energy limit.
5. Free particles are matter or systems with excess-energy.
6. Unity force (Fu) is matter's tendency of being unity, expressed as attracting while energy sharing in a unity or repelling while excess-energy releasing out of the unity.
    1) Matter attracts other matter to share energy while its energy is below its energy limit (attracting while energy sharing) until being a new unity.
    2) A free particle repels other matter while releasing its excess-energy (repelling while excess-energy releasing) until being unity.
    3) Breaking a unity requires strong enough initial energy. Then, a new unity begins in the new situation. The more energy is shared in a unity, the more initial energy is required to break the unity.
7. *Dynamic unity:* matter or a system moves to be unity, expressed as two distinct types of oscillations:
    1) Matter of a unity oscillates around (orbits) the centre of the unity (unity centre) to share energy, like an electron orbits its atomic nucleus, or a planet orbits its star. The orbit is the equilibrium of its unity force.
    2) A free particle oscillates away or about the energy source to release its excess-energy, forming particle waves.
        i. Almost massless, a photon or a neutrino oscillates away as light, its visibility depending on its excess-energy[5].
        ii. With larger mass, an electron oscillates away or about the energy source, showing magnetic effects, and in turn oscillates away a photon as light.

Here, mass and energy must be defined clearly:

1. Mass is matter's unity mass (Mu), also called rest mass (m), because "rest" means in a unity.
2. Energy is matter's total energy E: E = Ep + Ee, where Ep is energy limit or potential energy, and Ee is kinetic excess-energy. When in unity, Ee = 0.
3. Matter's total energy E expresses as its unity force Fu, so that E >= Fu >= Mu:
    1) *At the lowest level:* when in unity, matter's unity force Fu equals its unity mass Mu[3]: Fu = Mu.
    2) At the highest level, Fu = E, which shows the attracting force of nuclear fusion of a black hole. Albert Einstein proposed that: $E = mc^2$ [6], where c is the speed of light, although due to the below two points, this equation is questionable.
4. Mass does not change into energy, nor vice versa, not even in nuclear fusion or nuclear fission (see the Nuclear Fusion and Nuclear Fission sections).
5. Mass and energy are not physical entities, but properties of matter, and independent of each other. The concept of mass-energy equivalence ($E = mc^2$) is deemed as a misconception.

III. The Origin of the Electron

The Big Bang created four base particles[3]: proton, electron, neutrino, and photon, in descending order of mass.

Then, each proton (p) shares energy with a neutrino (ν) as a proton unity (pν), because their mass fit each other to be a unity:

$$p + \nu \rightarrow p\nu$$

Each electron (e) shares energy with a photon (γ) as an electron unity (eγ), also because their mass fit each other to be a unity:

$$e + \gamma \rightarrow e\gamma$$

Proton unities and electron unities are called base unities.

So, I propose and summarize:

1. The Big Bang created the electron as one of the four base particles.
2. An electron tends to be in an electron unity (eγ), where the electron is the unity centre.
3. Because of its mass, and its unity with a photon, the electron is a perfect action agent in nuclei, atoms, and molecules.

IV. The Electron in Nuclear Fusion

In the nuclear fusion centre, those base unities are so dense and hot, and their energy limits are raised so high, they become attracting and energy sharing. That is, nuclear fusion is unity force in action, mainly through the proton-proton chain reaction[7], shown as the following simplified steps, updated from my original version[3]:

1. Two proton unities and two electron unities share energy to form a hydrogen-2 nucleus called deuterium, releasing a high-energy neutrino (ν^+), a high-energy electron (e^+ or positron) and a high-energy photon (γ^+ or gamma ray):

$$2\,p\nu + 2\,e\gamma \rightarrow {}^2p\nu e\gamma + \nu^+ + e^+ + \gamma^+$$

2. The deuterium $^{2}p\nu e\gamma$ shares energy with another proton unity to form a helium-3 nucleus, releasing another high-energy photon (γ^{+} or gamma ray):

$$^{2}p\nu e\gamma + p\nu \rightarrow {}^{3}p^{2}\nu e + \gamma^{+}$$

3. Two helium-3 nuclei share energy to form one helium-4 nucleus and release two proton unities to continue the process:

$$^{3}p^{2}\nu e + {}^{3}p^{2}\nu e \rightarrow {}^{4}p^{2}\nu^{2}e + 2\,(p\nu)^{+}$$

4. The helium-4 nucleus, $^{4}p^{2}\nu^{2}e = 2(^{2}p\nu e)$, becomes repelling while releasing the excess-energy mentioned above and moves out of the fusion centre to the outer core as the nucleus unity, and the product of the fusion.
5. Or the helium-4 nucleus $2(^{2}p\nu e)$ shares more energy with other nuclei or proton unities to form a heavier nucleus unity: $n(^{2}p\nu e)$, where atomic number $n > 2$, if the situation permits.
6. Therefore, in a newly formed nucleus unity from nuclear fusion, every electron shares energy with two protons and one neutrino: $n(^{2}p\nu e)$, where the atomic number $n >= 2$. Although isotopes happen, this is the main composition.
7. Absent from nuclear fusion, a hydrogen nucleus has only one proton unity ($p\nu$).

So, I propose and summarize:

1. Nuclear fusion is the unity force in action, creating nuclei so that every electron shares energy with two protons and one neutrino as $n(^{2}p\nu e)$, where atomic number $n >= 2$. Thus, unity force replaces strong force and quantum chromodynamics[8].
2. Excess-energy releasing is an important aspect of unity force, to maintain the newly produced unities. Besides being an energy sharing agent, the electron is also an excess-energy releasing agent (e^{+}) in nuclear fusion.
3. The "positron" here is re-defined as the high-energy electron, not the original meaning of "positively charged electron". According to the Principles of Matter, matter's energy is scalar, not vector. Any "antimatter" is a misconception, including the concept of a "positively charged electron", and the idea of "annihilation".
4. In the above nuclear fusion process, mass does not change into energy, nor vice versa.

V. The Electron in Atom Formation

Around 380,000 years after the Big Bang, out of the fusion centres in the disks of the star systems, the temperatures were eventually cool enough for the nuclei to capture electron unities ($e\gamma$), forming the first atoms and making the cosmos transparent:

1. Absent from nuclear fusion, each free proton unity attracts and shares energy with an electron unity in its orbit, forming a hydrogen atom: $(p\nu) + (e\gamma)$.
2. Each of the helium-4 nucleus created in the fusion centres and moved out, shares energy with two electron unities in its orbit, forming a helium atom: $2(^{2}p\nu e) + 2(e\gamma)$.
3. The heavier nuclei form atom unities the same way, with the same numbers of protons and electrons: $n(^{2}p\nu e) + n(e\gamma)$, where atomic number $n > 2$.

VI. The Electron in Beta Decay

As stated in the last section, nuclei of helium and heavier atoms are created in nuclear fusion centres by every electron sharing energy with two protons and one neutrino: $n(^{2}p\nu e)$, where atomic number $n >= 2$.

In a nucleus $n(^{2}p\nu e)$, every (pe) is shown as a neutron. That is, a neutron $= (p + e)$, which will be proved as follows.

According to the Laws of Unity, breaking a unity requires strong enough initial energy.

In the case of beta decay, the strong enough initial energy mostly comes from random sources of the environment (besides manually induced in nuclear fission), including high-energy photons (gamma rays, X-rays), cosmic rays, high-energy neutrinos or high-energy electrons from other beta decays.

In those unstable nuclei (easily broken unities), the initial energy causes two types of beta decays:

1. *Electron emission*[9]. Initial random energy breaks free an electron and a neutrino shared with two protons, causing one more proton and one less neutron:

$$pe\nu \rightarrow p + e^{+} + \nu^{+}$$

The broken-free neutrino (ν^{+}) carries the excess-energy away as invisible light. The broken-free electron (e^{+} or positron) transfers the excess-energy to a normal electron unity ($e\gamma$), producing a gamma ray or X-ray (γ^{+}), depending on the energy level.

An example of electron emission is the decay of carbon-14 into nitrogen-14 with a half-life of about 5,730 years[10].

Carbon-14 has 6 protons and 8 neutrons in its nucleus ($^{14}p^{6}\nu^{8}e$). In this decay process, carbon-14 ($_{6}C$) has a neutrino and an electron broken free with high energy, adding one proton and reducing one neutron, producing nitrogen-14 ($_{7}N$), that has 7 protons and 7 neutrons ($^{14}p^{5}\nu^{7}e$):

$$(^{14}p^{6}\nu^{8}e) \rightarrow (^{14}p^{5}\nu^{7}e) + \nu^{+} + e^{+}$$

In the produced nitrogen-14, $7(p) = {}_{7}N$, and $7(pe) = 7$ neutrons; the high-energy neutrino ν^{+} is an invisible light particle in its beginning, and the high-

energy electron e^+ transfers its high-energy to an electron unity ($e\gamma$), producing another invisible light γ^+.

The atomic number is increased because the periodic table only counts protons.

2. *Electron capture*[11]. Initial random energy can also energize an electron in the orbit of an unstable nucleus. The energized orbiting electron can break the unity of its nucleus, forming a new unity with two protons, causing one less proton and one more neutron:

$$e^+ + p\nu \rightarrow pe + \nu^+$$

releasing a high-energy neutrino ν^+ as excess-energy and invisible light.

An example of electron capture[11] is the decay of aluminium-26 into magnesium-26 with a half-life of about 717,000 years.

Aluminium-26 has 13 protons and 13 neutrons ($^{26}p^{13}\nu^{13}e$). In this decay process, one high-energy electron joins a nucleus of aluminium-26 ($_{13}Al$), reducing one proton and adding one neutron, making it into magnesium-26 ($_{12}Mg$), that has 12 protons and 14 neutrons ($^{26}p^{12}\nu^{14}e$):

$$(^{26}p^{13}\nu^{13}e) + e^+ \rightarrow (^{26}p^{12}\nu^{14}e) + \nu^+$$

In the produced magnesium-26, 12(p) = $_{12}Mg$, and 14(pe) = 14 neutrons. The high-energy neutrino ν^+ is the released and transferred excess-energy as invisible light.

The atomic number is decreased because the periodic table only counts protons.

So, I propose and summarize:

1. Beta decay is also unity force in action: in the unstable nucleus unities, outside initial energy can break out a neutrino and an electron (electron emission) as excess-energy; or break in an electron (electron capture) and break out a neutrino as excess-energy; leaving most of the original particles to share energy as new nucleus unities. Thus, unity force also replaces weak force[12].
2. In beta decays, as energy sharing agents, as well as excess-energy releasing and transferring agents, electrons maintain the newly produced unities.
3. As stated in the last section, the concept of a "positively charged electron" is a misconception. Beta decays should be categorized into electron emission and electron capture, instead of "negative or minus" and "positive or plus".

VII. The Electron in Nuclear Fission

Nuclear fission is also a type of beta decay, where strong enough initial energy breaks an unstable nucleus unity, leading to new unities while releasing excess-energy. The released excess-energy can cause chain reactions, if situations permit.

A famous example is U-235 ($_{92}U$) decaying into Kr-92 ($_{36}Kr$) and Ba-141 ($_{56}Ba$)[13].

Uranium-235 has 92 protons and 143 neutrons ($^{235}p^{92}\nu^{143}e$). In this decay process, one high-energy neutron $(pe)^+$ is induced into the nucleus of uranium-235 ($_{92}U$), breaking it into two smaller nuclei: 1) Krypton-92 ($_{36}Kr$), that has 36 protons and 56 neutrons ($^{92}p^{35}\nu^{56}e$); and 2) Barium-141 ($_{56}Ba$), that has 56 protons and 85 neutrons ($^{141}p^{55}\nu^{85}e$); and releasing three more high-energy neutrons $(pe)^+$ and three high-energy neutrinos ν^+:

$$(^{235}p^{92}\nu^{143}e) + (pe)^+ + \nu^+ \rightarrow (^{236}p^{93}\nu^{144}e) \rightarrow$$

$$(^{92}p^{35}\nu^{56}e) + (^{141}p^{55}\nu^{85}e) + 3\,(pe)^+ + 3\,\nu^+$$

The produced 3 $(pe)^+$ and 3 ν^+ are the released and transferred excess-energy, which will cause chain reactions if situations permit.

So, I propose and summarize:

1. In nuclear fission, the released energy comes from the potential energy of the source atoms, not from their mass.
2. The source unstable nuclei have stored large amounts of potential energy when created from nuclear fusion, which makes them unstable.
3. The produced Kr-92 and Ba-141 also have enough potential energy to be unstable and radioactive, and can beta decay into smaller and more stable atoms while releasing more high-energy electrons, neutrinos, and photons.

VIII. The Electron in Electromagnetism

According to current knowledge, electromagnetism or electromagnetic radiation[14] is the flow of energy at the speed of light through space or a material medium in the electric and magnetic fields that make up electromagnetic waves such as radio waves, visible light, and gamma rays. In such a wave, electric and magnetic fields are mutually linked with each other at right angles and perpendicular to the direction of motion. An electromagnetic wave is characterized by its intensity and the frequency of the electric and magnetic fields. In quantum theory, electromagnetic radiation is the flow of photons through space.

According to the Principles of Matter, electromagnetic radiation is just electron waves releasing excess-energy as photon waves.

In an electric field or a conductor, when electrons get excess-energy from an electric source that has a potential difference (voltage) for direction of motion, they oscillate away from the energy source (causing wave-particle duality) as electron waves with

magnetic effects (wave property), perpendicular to the simultaneously caused electric current (particle property), and in turn oscillating away their bonded photons as light, at right angles from the electrons:

1. The electrons oscillate away from their energy source (the electric source) as far away as possible, which is perpendicular from the direction of the simultaneous electric current.
2. The photons also oscillate away from their energy source (the electrons) as far away as possible, which is at right angles from the electrons. That is why the magnetic waves (photon waves actually) are at right angles from the electron waves.

So, I propose and summarize:

1. In materials without outside forces:
   1) Most electrons are in atom unities. For the rest, occasional free electrons, their waves are random and cancel each other out without magnetic effects.
   2) Some materials, like iron, have more free electrons that can be aligned, showing some magnetic effects. A magnet has many more free electrons that are already aligned when created.
2. In an electrical conductor, outside forces can break free the outermost electrons, align and intensify their waves, and form electric currents simultaneously.
3. These aligned and intensified electron waves in turn oscillate away the photons bonded with the electrons, causing photon waves (light).
4. Magnetic effects result from stronger electron waves aligning weaker electron waves. After aligned, they become attractive to each other, because aligning is energy sharing. For example, a magnet or an electric source that has stronger electron waves align and then attract small iron pieces that have weaker electron waves.
5. Electromagnetic radiation is electron waves showing magnetic effects while releasing excess-energy as photon waves. So, electromagnetism is the unity force of free electrons, and should be called electronism.
6. Therefore, there are no such things as magnetism, magnetic fields, or magnetic waves. They are just electron fields with electron waves releasing excess-energy as photon waves.

IX. Electrical Conductor, Insulator, Currents, and Electricity

An electrical conductor is: 1) a material, usually a metal, whose outermost electron of any atom can be easily broken free by an electric force; 2) an electrolyte with many free electrons, like battery electrolyte or organic tissues; or 3) a state of plasma filled with free electrons.

On the other hand, an electrical insulator is a material, like plastic, whose outermost electron of any atom cannot be easily broken free by an electric force.

When in an atom unity, electrons oscillate around their nucleus, attracting while energy sharing. Outside electric forces can break free those outermost electrons from the atom unities of a conductor, oscillate them away (causing wave-particle duality), align and energize them, forming stronger electron waves with magnetic effects (the wave property), and simultaneously cause them to flow along the potential difference as electric currents (the particle property).

Electricity is the synchronized repelling force of the electric currents, in which each electron transfers its excess-energy to an electrical device or to its bonded photon causing light.

After transferring all its excess-energy, the electron joins in an atom unity that lost an electron previously, attracting while energy sharing again.

The free electron's excess-energy is kinetically repelling and gradually reducing. The concept of an electron having a specific "electric charge" is a misconception. The concepts of "negative" or "positive" charges are also misconceptions.

X. Anode and Cathode to High-End and Low-End

As stated above, electron waves (with magnetic effects) and electric currents happen simultaneously, and the currents flow from high energy to low energy.

For indicating the directions of electrical currents, I suggest that, instead of using Anode and Cathode, we should use:

1. *High-end (+):* the end with more energetic and repelling electrons, hence the high kinetic (voltage) end.
2. *Low-end (–):* the end with less energetic and repelling electrons, hence the low kinetic (voltage) end.

XI. The Electron In Chemistry

Chemistry is the study of electron actions in atoms and molecules. It is also the study of breaking original unities and forming new unities in new situations. Therefore, chemistry is the unity force in action, where electrons are action agents for energy sharing (electron sharing or chemical bonding), excess-energy releasing, and energy transferring in atom and molecule unities.

1. *Electrons in Molecules: As Energy-sharing Agents*

The process of hydrogen burning into water, updated from my original version[4], is a chemical reaction:

$$2H_2 + O_2 \rightarrow 2H_2O + \text{energy (light and heat)}$$

But if we look deeper, we see that any chemical reaction is just a physical process.

a) The Reactants - the Hydrogen (H-H) and Oxygen (O=O) Molecules

Chemically, a single covalent bond bonds two hydrogen atoms; a double bond bonds two oxygen atoms.

Physically, the reactants were unities in their situation, the bonds being shared electrons as shared energy:

1) The two hydrogen atoms share energy by sharing the only two electrons between them to be a molecule unity (H:H).
2) The two oxygen atoms also share energy by sharing two pairs of electrons (4 electrons) to be a molecule unity (O::O).

b) Ignition and Bond Breaking

Strong enough energy (a spark or flame) is required to break the bonds of the hydrogen and oxygen molecule unities:

Chemically, the ignition energy breaks the H-H bonds in hydrogen molecules, and the O=O bond in the oxygen molecule; the molecules become individual atoms.

Physically, from the ignition energy, the sharing electrons in the molecule unities get excess-energy and oscillate away as free electrons (e^+), freeing up H atoms and O atoms (+sign indicating high energy and repelling; the ignition also provides more free electrons):

$$H{:}H \rightarrow 2\,H + 2\,e^+$$

$$O{::}O \rightarrow 2\,O + 4\,e^+$$

c) Bond Formation

Chemically, the free oxygen and hydrogen atoms form new bonds to create water molecules (H-O-H): each oxygen atom forms bonds with two hydrogen atoms. The process releases more energy than was required to break the original bonds, keeping the process going.

Physically, an increased energy limit by the ignition energy gave the free hydrogen and oxygen atoms the chance to share energy by sharing two pairs of electrons, forming the H:O:H unity in the new situation, and producing excess-energy:

$$4\,H + 2\,O + 8\,e^+ \rightarrow 2\,H{:}O{:}H + 8\,e^+$$

1) The newly formed free H:O:H molecules (water vapor) become repelling while releasing the excess-energy, causing more heat.
2) The free electrons (e^+) can also be used elsewhere (for example, battery energy in fuel cells), or transfer their excess-energy to their bonded photons (γ) and oscillate them away as light (γ^+):

$$e^+ + \gamma \rightarrow e + \gamma^+$$

3) The excess-energy keeps the process going if there are more H:H and O::O.

This process proves that electrons are energy-sharing agents in a molecule. Before the reaction, the atoms share energy by sharing electrons in their molecule unities. In the reaction, the atoms release the freed-up electrons as excess-energy.

2. *Electrons in Molecules: As Excess-energy-releasing Agents*

Before a chemical reaction, any reactants are unities. According to the Principles of Matter or the Laws of Unity[3]: to break a unity, strong enough initial energy is required, although in some situations, the reactants provide the initial energy, for example, in the following chemical reaction:

$$H\text{-}Cl + Na\text{-}O\text{-}H \rightarrow H\text{-}O\text{-}H + Na\text{-}Cl$$

1) when dissolved into water, the reactants H-Cl and Na-O-H release their potential energy:

$$H{:}Cl + 2\,H{:}O{:}H \rightarrow H{\cdot}H{:}O{:}H + Cl{\cdot}H{:}O{:}H + 2\,e^+$$

$$Na{:}O{:}H + 2\,H{:}O{:}H \rightarrow Na{\cdot}H{:}O{:}H + H{:}O{:}H{\cdot}O{:}H + 2\,e^+$$

The releasing of high-energy electrons e^+ as excess-energy causes water vapor and makes the solution electrically conductive.

2) $Cl{\cdot}H{:}O{:}H + Na{\cdot}H{:}O{:}H \rightarrow Na{:}Cl + 2\,H{:}O{:}H$

The pair of electrons in the produced Na:Cl are easily broken free, causing the solution to be more electrically conductive.

3. *Electrons in Molecules: As Energy-transferring Agents*

1) *Batteries*

An electrochemical battery[15,16] produces electricity by connecting two different metals in a chemical substance called an electrolyte. A chemical reaction between the metals and the electrolyte frees more and higher energy electrons in one metal than in the other[17].

The metal that frees more and higher energy electrons becomes the high voltage end (high-end), and the other metal becomes the low voltage end (low-end).

When an electrical conductor (wire) connects one end of the battery to the other, electrons flow through the wire from high-end to low-end.

When an electrical device, such as a light bulb, is connected along the wire, the electricity can do work as it flows through the wire and the light bulb from the high-end to the low-end of the battery.

For example, one kind of battery is based on the redox reaction[16]:

When a piece of zinc metal (Zn) is immersed in an aqueous solution of copper sulfate ($CuSO_4$), dark-coloured copper metal will collect on the surface of the zinc metal and the blue coloured Cu ion disappears from the solution. The solution now contains zinc ions, as represented below:

$$Zn + Cu{:}SO_4 \longrightarrow Zn{:}SO_4 + Cu$$

Where Zn is oxidized to $Zn{:}SO_4$ while $Cu{:}SO_4$ is reduced to Cu. Electrons have transferred from Zn to Cu ion, changing Cu ion to Cu.

In this process, if a wire and an electrical device is linked to both ends of the battery, the electrons will flow from high-end to low-end and do work.

2) *Fuel Cells*

Fuel cells[18] are devices that convert the chemical energy of a fuel directly into electricity by electrochemical reactions.

Fuel cells have essentially the same components as a battery. Each cell of a fuel cell system has a matching pair of electrodes: the high-end to supply electrons and the low-end to absorb electrons. Both electrodes are immersed in and separated by an electrolyte, which may be a liquid or a solid, conducting ions or low-energy electrons between the electrodes to complete the chemical reaction.

A fuel, such as hydrogen, is supplied to the high-end and oxidized by oxygen provided, producing hydrogen ions, oxygen ions, and high-energy electrons. The high-energy electrons provide electricity to the high-end, while the hydrogen ions and oxygen ions move to the low-end, where they absorb low-energy electrons (energy being used) and form water. The chemical and physical processes have been shown in the previous section, and the following represents the result:

$$2\,H{:}H + O{::}O \rightarrow 2\,H{:}O{:}H + 8\,e^{+}$$

XII. Conclusion

1. The Big Bang created four kinds of base particles[3]: proton (p), electron (e), neutrino (ν), and photon (γ).
2. The electron usually shares energy with a photon as an electron unity (eγ), except in a nucleus formed in a nuclear fusion centre, where the photon oscillates away with excess-energy as gamma rays.
3. The electron tends to be unity:
   1) Absent from nuclear fusion, each free proton unity (pν) attracts and shares energy with an electron unity in its orbit, forming a hydrogen atom unity: (pν) + (eγ).
   2) In a fusion centre, each electron shares energy with two protons and one neutrino to form a nucleus unity: n(^{2}pνe), where atomic number n >= 2.
   3) Out of the fusion centre, atom unities are formed with the same numbers of protons and electrons: n(^{2}pνe) + n(eγ), where n >= 2.
4. Electrons move to be dynamic unity, expressed as two distinct types of oscillations[3]:
   1) Electrons of the atom unity oscillate around their nucleus, attracting while energy sharing. Each electron's orbit is the equilibrium of its unity force.
   2) Outside electric forces can break free those outermost electrons from the atom unities of a conductor, oscillate them away, align and energize them, forming stronger electron waves with magnetic effects, and simultaneously cause them to flow from high-end to low-end as electric currents. Electricity is the synchronized repelling force of the electric currents, in which each electron transfers its excess-energy to an electrical device or to its bonded photon causing light. After transferring all its excess-energy, the electron joins in an atom unity that lost an electron previously, attracting while energy sharing again.
5. Free electrons oscillate away from their energy source (the electric source) as far away as possible, which is perpendicular from the direction of the simultaneous electric current.
6. Free photons also oscillate away from their energy source (the electrons) as far away as possible, which is at right angles from the electrons. That is why the magnetic waves (photon waves actually) are at right angles from the electron waves.
7. The free electron's excess-energy is kinetically repelling and gradually reducing. Therefore, the following are misconceptions: 1) the concept of an electron having a specific "electric charge"; 2) the concepts of "negative" or "positive" charges; 3) the concept that electrons and protons are "oppositely charged".
8. Also, according to the Principles of Matter, matter's energy is scalar, not vector. Any "antimatter" is a misconception, including the concept of a "positively charged electron", and the idea of "annihilation".

9. Nuclear fusion is the unity force in action, creating nuclei so that every electron shares energy with two protons and one neutrino as n(^{2}pve), where atomic number n >= 2. Thus, unity force replaces strong force and quantum chromodynamics[8].
10. Beta decay is also unity force in action: in the unstable nucleus unities, outside initial energy can break out a neutrino and an electron (electron emission) as excess-energy; or break in an electron (electron capture) and break out a neutrino as excess-energy; leaving most of the original particles to share energy as new nucleus unities. Thus, unity force also replaces weak force[12].
11. Electromagnetism is electron waves showing magnetic effects while releasing excess-energy as photon waves. Therefore, electromagnetism is the unity force of free electrons, and should be called electronism.
12. Magnetic effects result from stronger electron waves aligning weaker electron waves. After aligned, they become attractive to each other, because aligning is energy sharing.
13. There are no such things as magnetism, magnetic fields, or magnetic waves. They are just electron fields with electron waves releasing excess-energy as photon waves.
14. In circuits and electrical networks, high kinetic end (high-end or +) and low kinetic end (low-end or –) are suggested for indicating electrical current directions.
15. Chemistry is the unity force in action, where electrons are action agents for energy sharing (electron sharing or chemical bonding), excess-energy releasing, and energy transferring in atom and molecule unities.

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