Redefining the Electron (Part 1): The Implications for Electricity

by

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Version 1, January 2019

Abstract

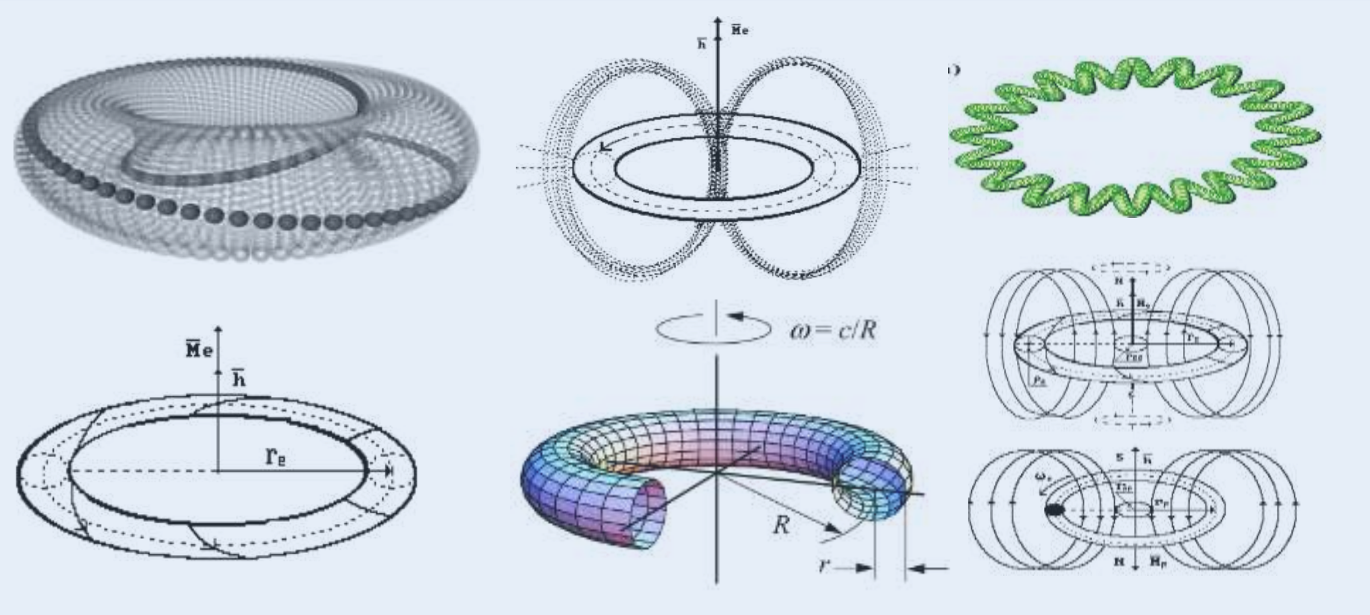
By redefining the electron to be a **toroidal solenoidal** form of concentrated energy, rather than the monopole point-charge definition underpinning the orbital nuclear atomic model of the Standard Model and Quantum Mechanics, the explanation of electromagnetism and electricity becomes more logical, straight forward and consistent. Redefining the Electron (Part 1) addresses the nature of electric and magnetic fields, electrons, positrons, electric current flow, electric capacitors and the induction of electric current.

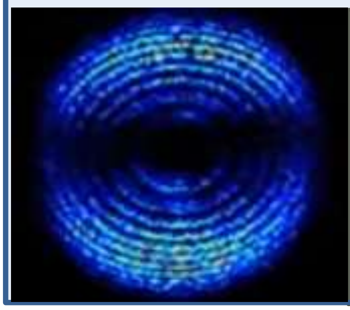
The follow-up paper, Redefining the Electron (Part 2), extends the **T**oroidal **S**olenoidal **E**lectron (**TSE**) model to explore the implications for atomic structure and the physical characteristics of elements in the Periodic Table, molecules and compounds; and how they interact with each other chemically. Part 2 examines the role of electrons and positrons within normal matter, providing insight into the particle-wave nature of EMR and alternative explanations for spectral line emission and absorption, the photo-electric effect, the Compton Effect, electron pair generation and annihilation, beta and electron capture radiation, and Gravity.

Toroidal Solenoidal Electron Definitions and Conventions

A **toroidal ring** model for electrons was first proposed by Alfred Lauck Parson in 1915. Originally known as the Parson magneton or magnetic electron, similar models have been variously called plasmoid rings, vortex rings, and helicon rings. Since 1997 there have been numerous papers, articles and videos related to torus models of electrons and photons: a representative sample of which is shown in figure 1.

W.H Bostick proposed a **toroidal solenoid** structure for the electron in 1956, with electric charge circulating internally at the speed of light. Along similar lines, this paper considers that the electron's torus consists of a fast moving **concentrated energy** continuum flowing in a swirling solenoidal pattern within a loop-like toroidal structure. The flow pattern forming the electron's torus **core energy** is considered to be accompanied by a swirling cloud-like atmosphere of less concentrated energy that moves in unison with the core energy to form its external **electromagnetic field**.





Picture left: A frame from [2008 video of an electron](#) made by Swedish scientists.

Picture right: A frame from of a **[Simple Universe](#)**® video. It considers the electron to have a toroidal structure made up of strand

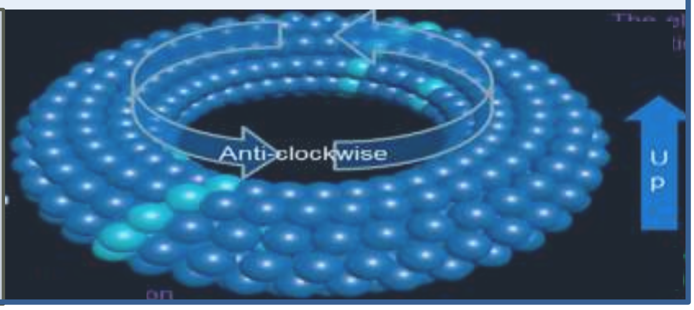


Figure 1: Examples of Electron/Positron Torus-based Models

Notations and conventions must first be established for consistency and so that, although the explanations might differ, the terminology of the **T**oroidal **S**olenoidal **E**lectron (**TSE**) model will be compatible with that defined and used by conventional Science. Referring to figure 2:

- The axial up/down component (**b**) of the external electromagnetic field defines the field's North/South magnetic orientation. The convention assumed is that the magnetic component of the field flows out from the electron's **North Pole** to return back at its **South Pole**. Alternatively, the electron's North Pole can be considered to be the **divergent** polar energy flow and its South Pole the **convergent** polar flow.
- The toroidal solenoidal swirling flow pattern of the electromagnetic field defines the electrical nature of the electron. To distinguish between a positive and a negative electric charge, the convention adopted is that a **clockwise** circular flow direction (**e**) represents a **positive** electric pole and an **anti-clockwise** flow direction the **negative** end when looking from outside towards the torus along its North-South axis.
- The electron/positron notation consists of a green torus, with the positive electric side of the electromagnetic field indicated in **blue** and the negative side in **red**. The magnetic orientation is not indicated by this notation.
- The flow pattern of the core energy and electromagnetic field defines the **chirality** (or helicity) of the toroidal solenoid. The convention adopted is that a N- (North-Negative) pole and S+ (South-Positive) chiral combination defines an **electron**, and that a N+ or S- pole combination a **positron**.

An electron and a positron each have a rest mass of 0.511 MeV/c^2, and only differ by having different chirality.

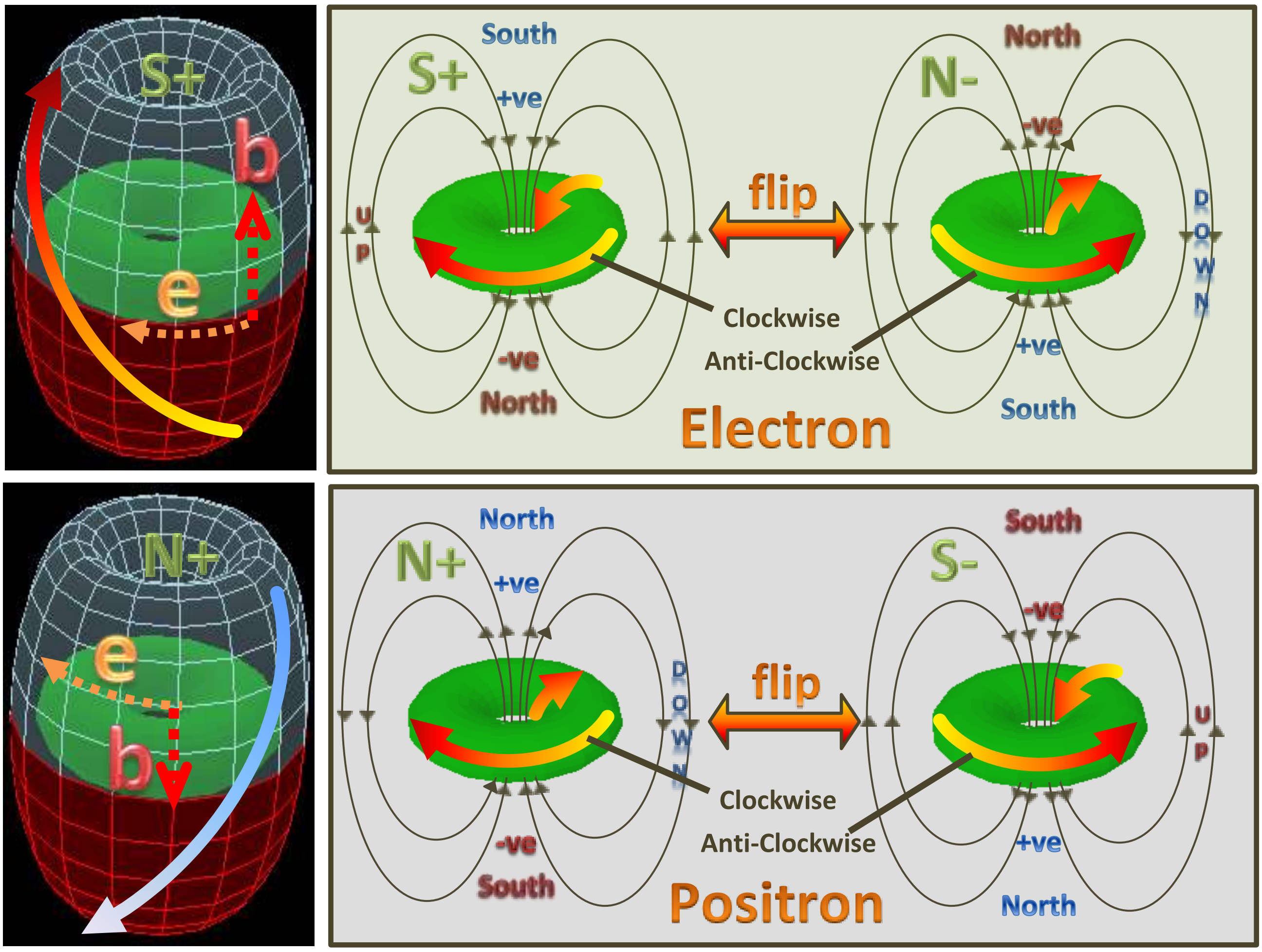


Figure 2: TSE Electron and Positron Electromagnetic Field Patterns

Not surprisingly, the TSE model does not sit well with the orbital nuclear model, the flagship of conventional Science as represented by the Standard Model and Quantum Mechanics, which rely upon a **monopole point charge definition** of an electron. For conventional Science a negative electric charge is defined by an excess of electrons; a positive charge is attributed to an atom's positively charged nucleus when it has a depleted number of orbital electrons compared with its stable neutral (i.e. number of electrons = number of protons = atomic number) configuration.

For TSE an **electric negative charge** has two forms: a N- pole or a S- pole. Similarly **an electric positive charge** is defined as a N+ pole or a S+ pole.

As for the conventional Science model, **electric field attraction** occurs when pairs of oppositely-charged electric poles are placed in close proximity, and **electric field repulsion** occurs when pairs of like-charged electric poles are placed in close proximity. For TSE there are two possibilities for opposite-pole attraction (pairs of N+ and N- or S+ and S- poles), and for electric pole repulsion there are four possibilities as shown in the yellow section of the figure 3 tabulations.

Situation	Electron		Positron		Effect
Electric field attraction	N-		N+		Point Charge
(electric charge)	S+		S-		Attraction
Electric field repulsion	N-	N-	N+	N+	Point Charge
(electric charge)	S+	S+	S-	S-	Repulsion
Electric current	N-	S+			End-on-end
(aligned electrons/positrons)			N+	S-	Attraction

Figure 3: Electric Charge Attraction and Repulsion Tabulation

TSE considers that free electrons and positrons exist in normal matter in approximately equal numbers. As the only physical difference between electrons and positrons is their chirality, it is most difficult, if not impossible, to distinguish between them within matter. Although electrons and positrons can easily be manipulated, such as by a Van de Graaff generator, it is most difficult to free positrons from matter (see Free Electron and Positron Farming). When positrons are forcedly removed from matter and travelling in free space, they can easily be separated from electrons by deflection with a magnetic field.

From a historical perspective, the foundations of electrical theory and the orbital nuclear model were laid down well before positrons were first identified in 1932 (after being predicted in 1928 by Dirac's wave equation, which also is one of the foundation stones of Quantum Mechanics): they just were considered to be some sort of mysterious cosmological anti-particle that was related to Beta radiation. Their importance was possibly overshadowed by Chadwick's discovery of the neutron in the same year, and they did not seem to have any relevance to the evolving nuclear orbital model which was becoming increasingly complex. They were simply added to the extensive list of anti-particles (which they are), listed as the anti-particle of the monopole electron (which they are not). The historical context of their discovery, combined with the difficulty of distinguishing them from the electron within matter and an obsession with the monopole electron, has led to the current situation wherein conventional Science does not entertain the possibility that positrons might or could exist within matter, let alone be just as important as the electron for electrical theory and practice.

Conventional Science encounters problems explaining electric currents in terms of the movement of free electrons alone, particularly at the micro-level required for semiconductor circuitry design and nanoscience. It is forced to introduce the abstract concept of a positive charge carrier, the **electron hole**, to compensate its lack of positrons.

An electron hole is a notional positive charge that marks the absence of electrons in one or more outer orbitals within an atom, which, within an electric current, are considered to move in the opposite direction to that of free electrons. In effect, the conventional Science approach has dug a hole for itself because the electron hole is a compromise that functionally takes on the role of the positron. It is needed to compensate for the lack of recognition of the importance of the positron within normal matter. Redefining the Electron explores just how deep this hole might be.

Now that the basic TSE assumptions, conventions and definitions have been made, we can move on to see how electrons and positrons form electric currents and electric lines fields.

Electric Currents, Capacitors and Electric Fields

A good electrical conductor (e.g. a section of copper wire) contains approximately equal numbers of free electrons and positrons evenly distributed throughout the medium. An electric current is generated whenever the free electrons and positrons are axially aligned by an emf that has been created by magnetic induction or by changing the free electron to positron ratio within parts of the conductor. Causes of free electron and positron imbalance are manifold, including heat energy (e.g. thermo-electric cells); EMR (e.g. photovoltaic cells); chemical (e.g. chemical batteries); or surface effects (e.g. plasmons and static electricity).

In order to fully explain how electrons and positrons form into an electric current that in turn generates a magnetic field, four states of a basic electric circuit will be considered: a) no power source; b) open circuit with power source connected; c) open with a capacitor in line; and d) power source in place but with a break of circuit (i.e. switched off).

a) No power source

Consider this option to be represented by a length of copper wire not connected to any circuitry. It contains approximately equal numbers of free electrons and positrons dispersed evenly throughout the wire and randomly aligned to the electromagnetic fields within the wire's atomic lattice. Apart from possible heat related jostling and buffeting, there is no directional movement of electrons or positrons and no external magnetic field being generated.

b) Open circuit with power source connected

When an energy source applies an emf across an electric circuit, the free electrons and positrons almost instantaneously align and form into strand-like groupings. The strong end-on-end attraction (as per blue tabulation of figure 3) keeps them tightly connected and evenly spaced within their strand - somewhat like a tight conga-line (see the top section of figure 4). The different chiral spin direction of adjacent positron and electron strands causes them to synchronously worm screw-like in past each other in opposite directions, with electron strands moving towards the area of positron concentration (big blue +) and positron strands the negative area (red -), creating an electric current.

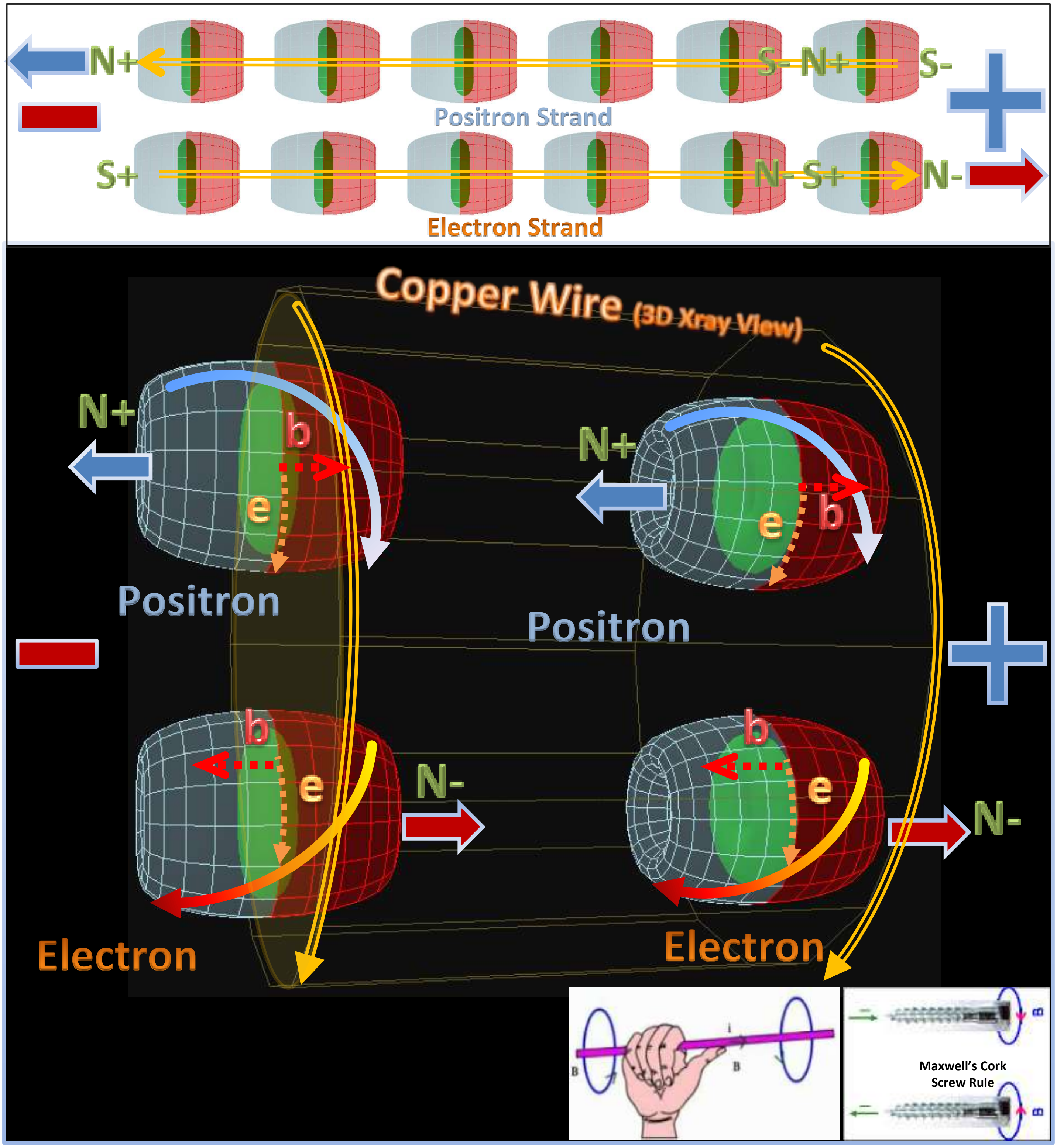


Figure 4: Electric Current: Electron and Positron Movement

The negative side of an open electric circuit thus acts as an **electron source** and a **positron sink**, and the positive side a **positron source** and an **electron sink**, resulting in TSE's reciprocating **source-to-sink** model for electricity flow.

The circular component of the electron and positron strand fields combine to create a **circular magnetic field** (∑e) around the outside of the wire in a direction conforming with Maxwell's Right-Hand Grip (or Cork Screw) Rule, both of which are shown as inserts at the bottom right of figure 4. The along-wire magnetic field components (b) moving outside the electron and positron core energy tori are in opposite directions and so cancel each other out.

Within strands the electromagnetic energy flowing through each core energy torus cumulatively combines so as to form a strong uninterrupted tunnel-like flow of electromagnetic energy through the centre of each strand as indicated by the orange/gold arrows in the upper part of figure 4. A similar effect occurs with the energy flow external to the core energy tori, but the axial flow of adjacent strands tends to cancel each other out. Strand-related energy flow is most important: it is responsible for the instantaneous nature of energy transfer by electricity and for the formation of the electric field patterns associated with electric point charges, which will be discussed shortly.

In summary, electric current (amperes) is defined as the amount of the electric charge (i.e. electrons and positrons combined) passing a fixed point in the circuit per unit time; and the emf across the circuit causes the alignment electrons and positrons, causing them to form into strands. The strand fields (i.e. the electric fields around strands) are responsible for the instant availability of energy and their total net strength is proportional to the emf applied.

Whenever an obstacle is encountered within an electric circuit, such as a resistor or a capacitor, the two-way movement between electron and positron strands is restricted, causing a proportional change in electric current. For a resistance forming the load for an electric circuit, Ohm's Law indicates that for a resistor of R ohms (Ω) and an electric potential difference of V volts the resulting electric current is V/R amperes when the circuit is open.

> An interesting aside: At this stage should we revert to a monopole point-charge for electrons and positrons, the electric current would be zero unless we replaced the positrons with notional positive electron holes.
>
> Along similar lines, the notion that an electric current consists of negative monopole electrons moving from an area low in electrons (the positive side of a circuit) to an area in electron surplus (the negative side), is problematic because electrons would be unable to get to the negative side due to like-pole repulsion. To counter this dilemma, either the direction of electron movement is reversed (negative to positive), or the electric current is interpreted to be notionally positive charges (yes, another example of those notional electron holes) moving from positive to negative. At very least, the conventional explanation of electric current in terms of negative monopole electrons is confusing, contradictory and logically wrong.

c) Open circuit with a capacitor in line

The **dielectric material** used in an electric capacitor is an electric insulator that allows a only limited number of free electrons and positrons to enter, holding onto them until the power source is removed (i.e. switched out as in figure 5); then the concentration of contained electrons and positrons causes an electric current in the reverse direction.

During the **charge phase (**leftmost in figure 5**)**, electrons accumulate within the dielectric resistor on the negative side within the active circuit as they cannot pass through the capacitor. Positrons moving in the opposite direction likewise accumulate within the dielectric medium on the positive side of the circuit. The build-up of accumulated electrons and positrons continues until no more can be accommodated within the dielectric, and the capacitor is then full with no current entering that section of the circuit.

For the **discharge phase,** the aligned positrons and electrons within the dielectric medium become the energy source. The concentration of electrons on the negative side of the capacitor becomes the electron provider and those on the positive side the positron provider: the result is a discharge current flowing in the reverse direction of the charging current.

Interestingly, the Wikipedia definition for a dielectric is '*an electrical insulator that can be polarised by an applied electric field*', and the explanatory diagram provided for 'dielectric polarisation' (duplicated bottom right in figure 5) uses electric dipoles that bear a remarkable similarity to the TSE model. It reflects the difficulty of explaining capacitance purely in terms of monopole electrons, and represents an unintentional endorsement of the TSE explanation which is based upon dipolar electrons and positrons.

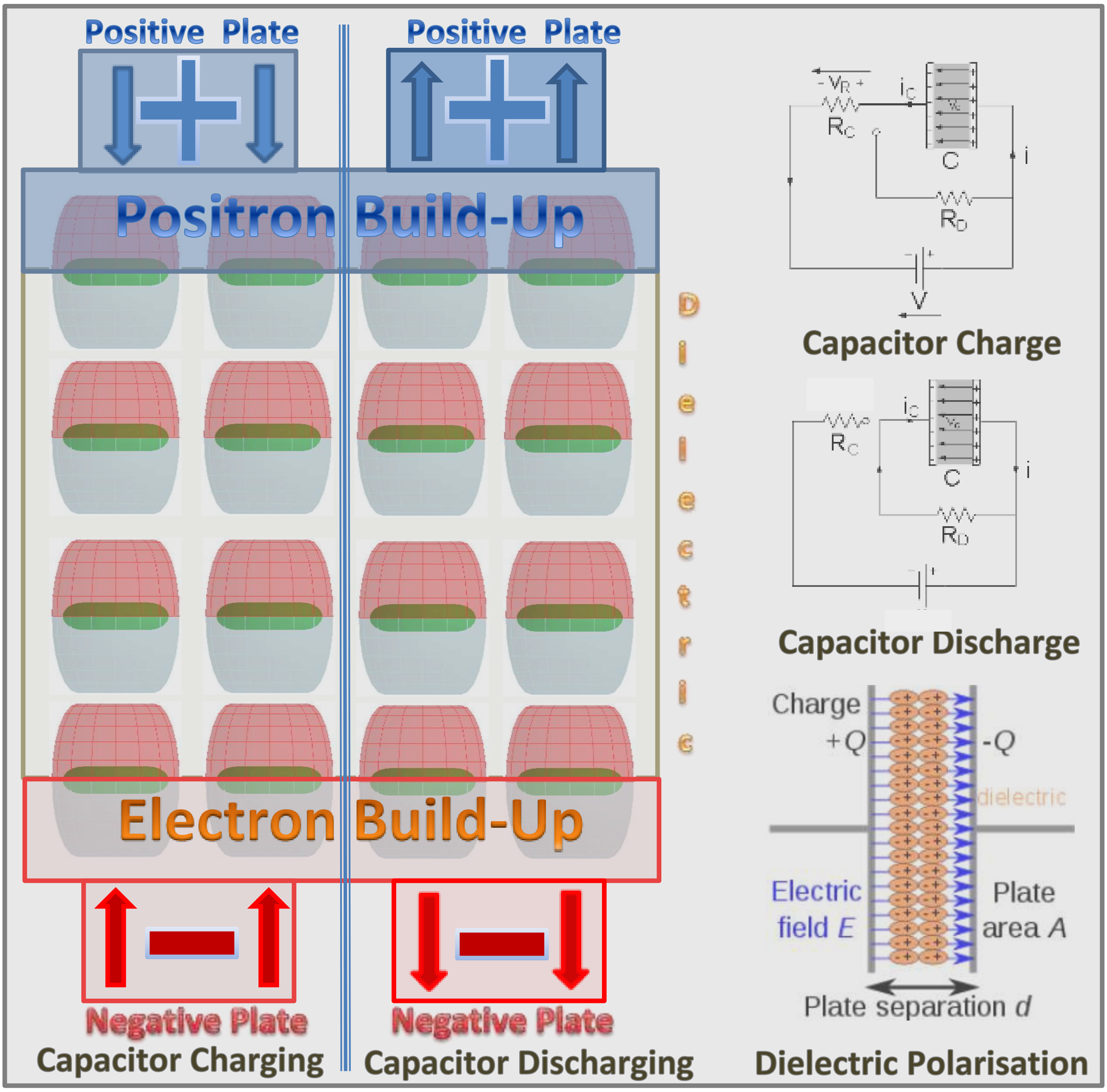


Figure 5: Electric Capacitor Charge and Discharge Phases

d) Power source in place but with a break of circuit (i.e. switched off mode)

Should a pair of probes be attached to an energy source (e.g. a battery or A-to-D converter) then we have a power source with a break of circuit; when the probes are brought together directly or indirectly via other circuitry we have an open circuit. When in circuit broken (OFF) mode, the rounded tips of each probe can be used to approximate one half of a pair of spherical **monopole electric charges** as in figure 6.

In OFF mode, the electrons on the negative side of the circuit are aligned within electron strands by the electron provider side of the power source, just as they would be should the circuit be open and a current allowed to flow. As there is no positron provider influencing the negative side, the aligned electrons in that section of the circuit cause the positrons to **flip** and align, facing the opposite direction that they would face should the circuit is opened. The result is a set of electron and positron strands with their North poles (N- and N+ respectively) facing the same way.

Thus, in OFF mode, the circular component the electron strand fields are now opposite to that of the positron strands, cancelling each other out so that there is no circular magnetic field around the probe wire. However, the along-wire magnetic field components (b), both inside and outside the electron and positron strands, flow in the same direction.

The North poles of both the electron and positron strands face outwards at the end of the probe on the negative side of the power source. The electric fields of positron strands barely extend beyond the surface of the probe. However, energised by the power source, the stronger electron strand fields extend well beyond the end of the probe as a negative electric field. On the positive side of the circuit, the positron strand fields similarly extend well beyond the end of the probe as a positive charge electric field.

Figure 6 represents the extended **strand fields** as long N- and N+ electron/positron polar electromagnetic fields, which follow the pattern of **electric lines of force** (imaginary continuous lines or curves drawn in an electric field, the tangent to which indicated the direction of the electric force at that point). The spherical **equipotential lines** for the electric fields around the electric point charges are also shown as blue and red dashed circles.

As the two probes are brought together, the N- to N+ attraction between the two becomes so great that electrons and positrons, being pushed from one side and pulled on the other, prematurely jump the gap, interfering with each other as the go, so generating heat and light in the form of an **electric spark**. When the two probes are in physical contact with each other (i.e. the circuit is now open or ON), the emf instantaneously flips the positrons on the negative side of the circuit and the electrons on the positive side. Thus the electrons and positrons, locked end-on-end within their strands, start to worm past each other, creating an electric current and a circular magnetic field around the probes and connecting wire.

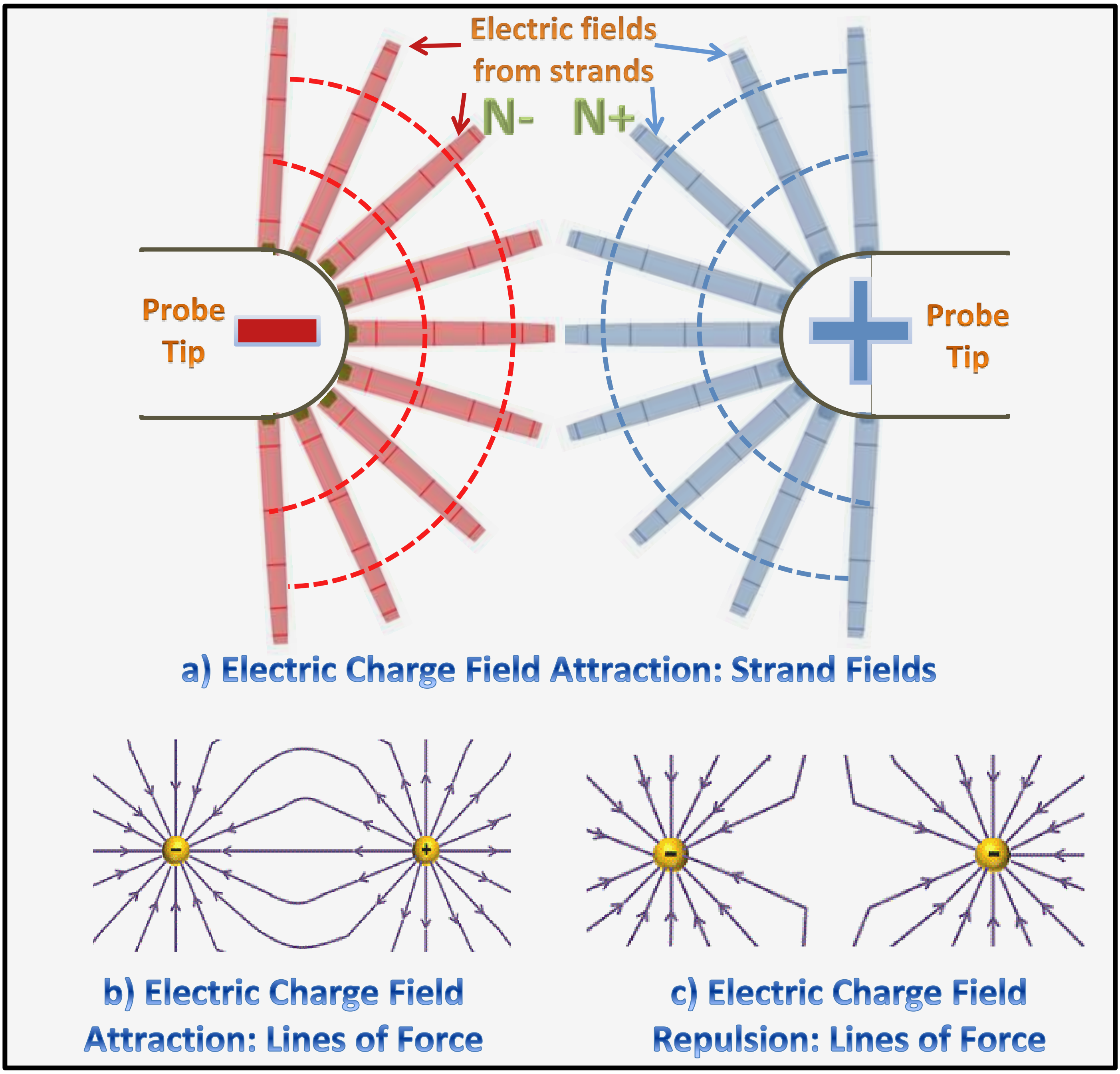


Figure 6: Monopole Electric Field Attraction and Repulsion

About Electron Flipping

Free electrons and positrons can re-orientate themselves in 3-dimensional space instantaneously in response to nearby electromagnetic fields. Under the influence of an external field that suddenly reverses, they respond by spinning 180° around any axis in the plane perpendicular to their own spin axis to face the opposite direction. Electron/positron flipping is most important within electric circuits and is the prime mechanism for converting protons into neutrons and vice versa, as will be addressed in Redefining the Electron (Part 2).

Van de Graaff Generators

A **Van de Graaff generator** is an electrostatic generator that uses a moving rubber belt to transfer charge to a hollow spherical metal structure and accumulate the charge to generate a very high electric potential up to several million volts.

For the positive charge generator (figure 7a), the upper roller (3) is acrylic glass or similar that loses electrons (electron source), which attach to the rubber conveyer belt and are moved down on the belt towards the lower metal roller. The acrylic roller is left with a positive charge due to the high positron-to-electron ratio (i.e. is a positron source).

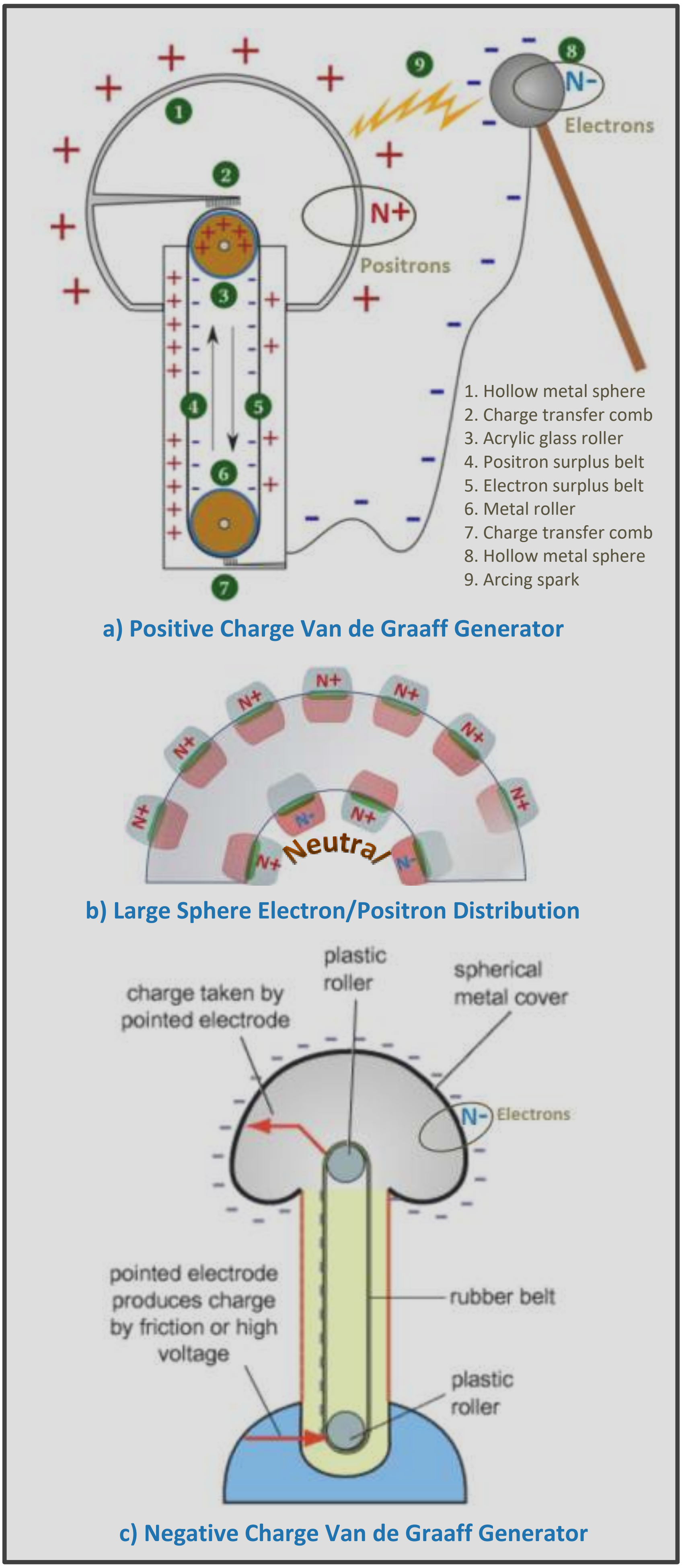
Many of the surplus electrons arriving at the lower metallic roller are extracted by the lower comb (7), creating an electron source that extends to the smaller metal sphere (8). Consistent with the TSE explanation of electric current flow, the electrons moving towards the small sphere cause reciprocal movement of positrons in the opposite direction, which in turn attach to the outer surface of the conveyer belt.

The upward-moving section (4) of the belt thus has a positron surplus which is harvested by the upper comb (2), building increased levels of positrons at the outer surface of the larger sphere (1) analogous to the electron build-up on the small sphere. Positron movement towards the large sphere is accompanied by the movement of electrons onto the moving conveyor belt via the comb (2).

Looking at a cross-section of the metal forming the larger hollow metal sphere (figure 7b), the arriving positrons spread up and around the sphere causing some electrons to migrate towards the inner surface of the hollow sphere and exit via the upper comb. At the large sphere's outer surface there is a considerable build-up of positron positive charge, but the inner surface maintains approximately equal numbers of electrons and positrons, keeping the inner surface electrically neutral.

The charge build-up on the spheres continues until equilibrium is reached with current no longer being generated across the combs.

The large electric potential difference between the positively and negatively charged spheres ionises air and water molecules between the



a) Positive Charge Van de Graaff Generator

b) Large Sphere Electron/Positron Distribution

c) Negative Charge Van de Graaff Generator

Figure 7: Van de Graaff Generators

two, creating low-level plasma. The plasma formation process quickly escalates into a large-scale charge transfer as an **electric arc** (9), as positrons and electrons are directly exchanged between the two spheres.

A negative charge version of the Van de Graaff generator (figure 7c) uses two plastic or acrylic glass rollers and does not harvest elections from the lower roller: positron build-up occurs within each roller and on the inner surface of the belt, with a high concentration of electrons on the outer surface of the up-belt. Quite often a high voltage is applied via the lower comb to supply the system with extra electrons thus increasing the charge build-up at the surface of the sphere.

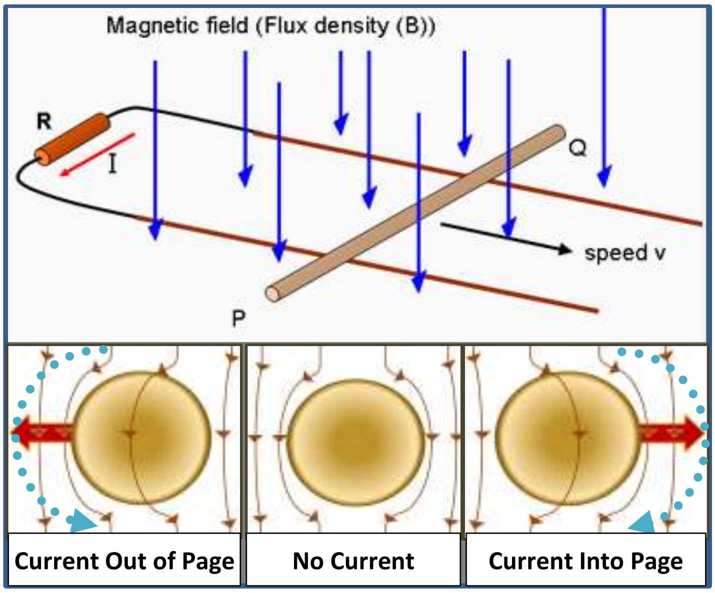


Figure 8: Magnetic Field Induced Current

Electromagnetic Induction

Faraday's Law of electro-magnetic induction states that whenever a conductor is forcefully moved in an electromagnetic field, an electromagnetic force (emf) is induced which causes a current to flow. For TSE, the current flow represents the synchronous movement of aligned free electron and positron strands within the conductor. For this discussion only the electron movement is referred to, but synchronous reverse movement of positrons is implicit.

In figure 8, the movement (at speed v) of rod conductor (PQ) through an external magnetic field (B) generates an anti-clockwise electric current (I) in the circuit.

The middle wire cross-sectional diagram of figure 8 represents flux deflecting around the rod when it is stationary within a magnetic field; the electrons and positrons are in effect shielded from the external magnetic field and thus no current results.

When the rod moves to the right, magnetic flux is forced to pass through the rod simulating a clockwise circular flowing magnetic field, causing the free electrons and positrons to align, and start moving as an electric current: the electrons shuffle move in the direction of into the page, which corresponds to

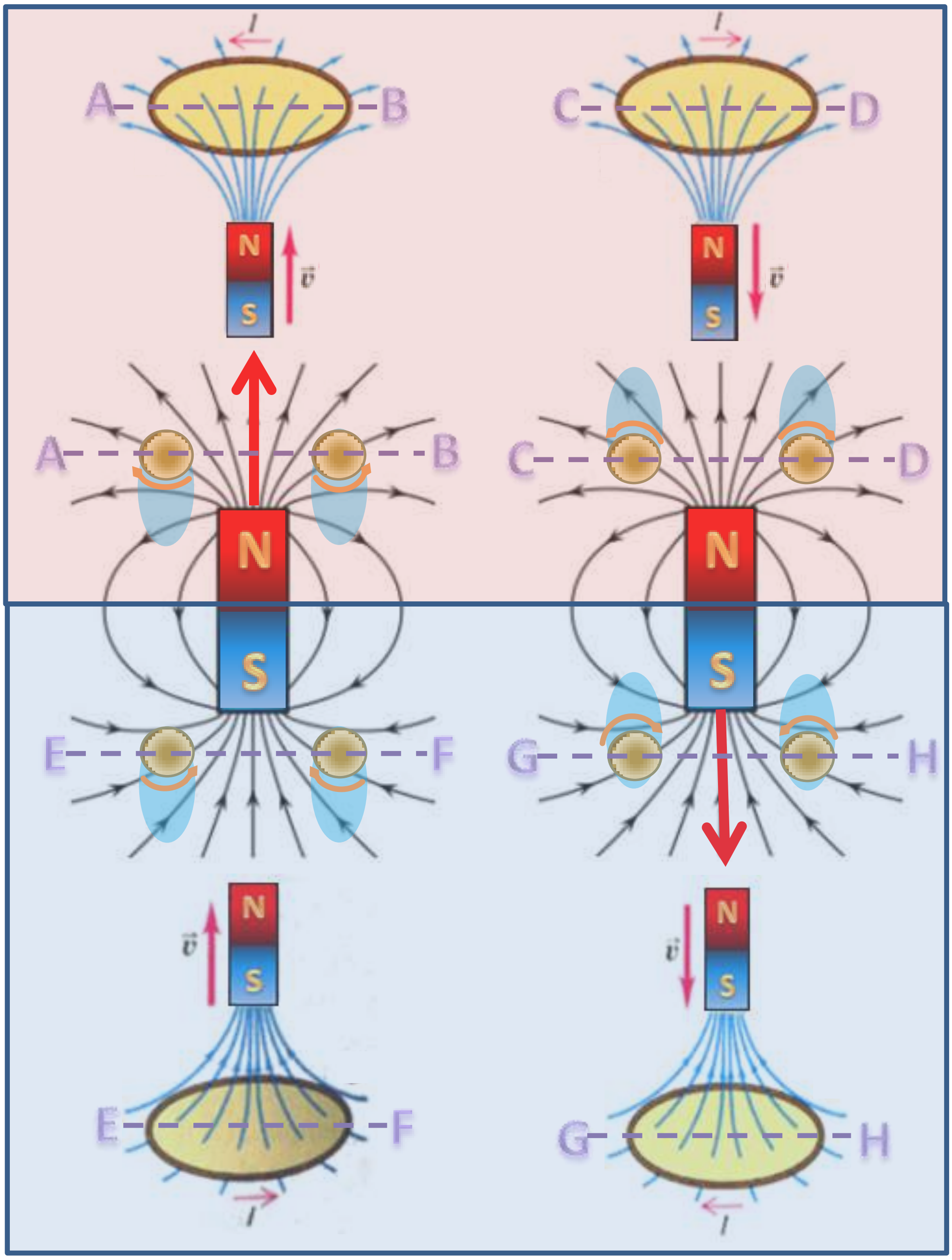


Figure 9: Magnet-Motion Induced Current within a Loop

Maxwell's Right-hand rule plus a clockwise circular magnetic field (shown as a blue dashed arc).

When the rod moves to the left (left-most diagram), the free electrons and positrons align in the opposite direction, reversing the electric current and circular magnetic field directions.

When the direction of the external magnetic field is reversed, the direction of the induced current and circular magnetic field is also reversed for each rod movement direction.

The TSE model provides a simple, consistent causative explanation for induced current, its direction and the associated circular magnetic field. Current Science texts and associated articles provide descriptive explanation rather than a causative explanation of these phenomena. They provide is a series of inter-related rules and conventions but no physical explanation, which adds mystery and confusion around electromagnetic induction and electricity.

The electromagnetic induction of a loop circuit caused by moving a magnet towards and away from it in different N-S polar orientations is shown in figure 9.

The key to understanding the direction of the loop current and the associated circular magnetic field is to look at the cross-sectional view of the loops (AB, CD, EF and GH).

The blue oval annotation attached to each loop cross-section indicates the direction from which the magnetic flux approaches: the flux passes through the loop, aligning the free electrons and positrons therein and generating a circular magnetic as shown by the orange arc arrows.

The direction of the induced loop current can be confirmed for each of the 4 scenarios by using Maxwell's right-hand grip rule. There is no mystery here – just simple Physics.

For **alternating current** (AC), created by switching current direction at a specific frequency, the TSE view considers that the aligned free electron and positron tori are simply flipped 180^{o} to reverse the electric current for each cycle. In other respects TSE and the conventional view are fully compatible, and as the techniques for creating AC electricity from induced currents (e.g. by rotating a U-shaped loop through a magnetic field) are well documented, as are the ways of creating and managing DC electricity: consequently they will not be addressed in this paper.

Chemical DC Electricity Generation and Recharge

The manner in which electrons and positrons are involved in chemical reactions is explained in Redefining the Electron (Part 2). In the meantime, figure 10 shows the conventional Science view of the chemistry of galvanic and electrolytic cells, but the description provided is in terms of the TSE interpretation involving both positrons and electrons.

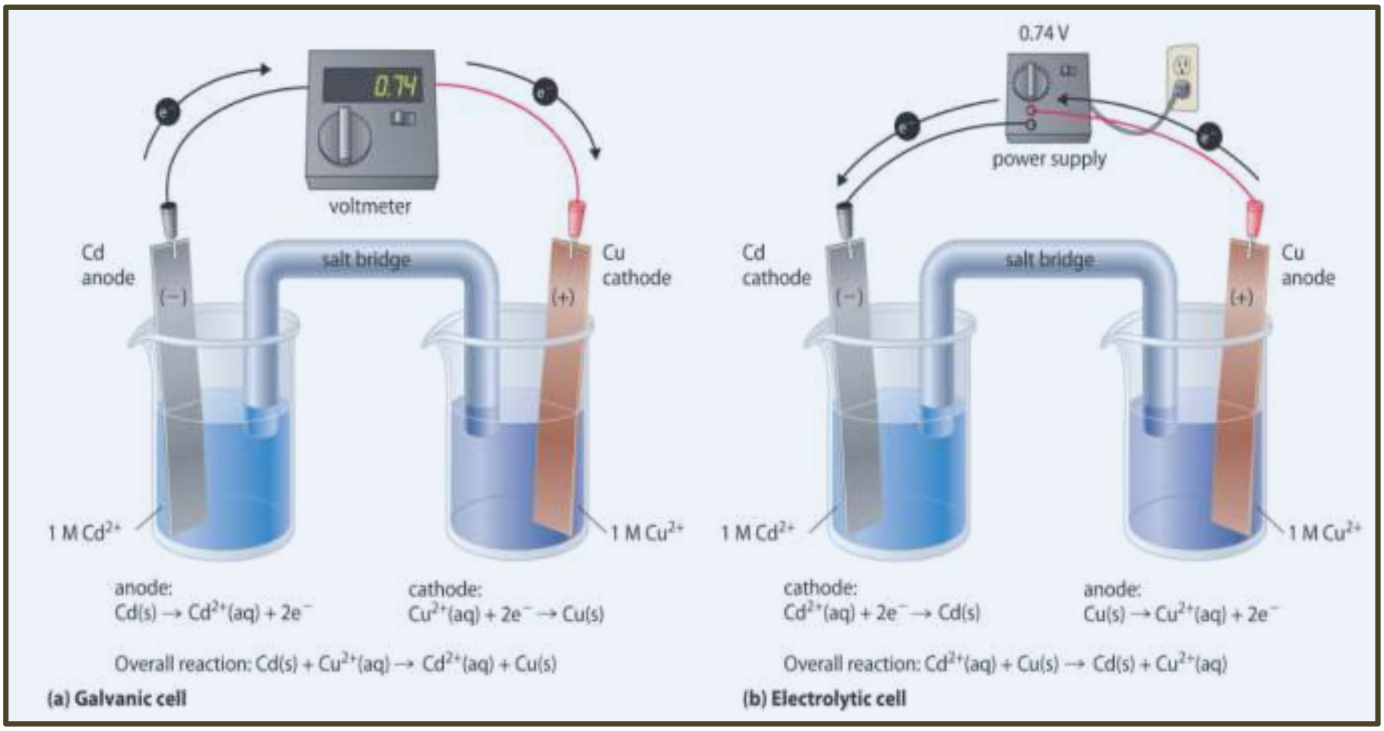


Figure 10: Galvanic and Electrolytic Cells

The **Galvanic Cell** example figure 10a creates Direct Current (DC) electricity by chemical reaction (i.e. is a chemical battery). At the anode, cadmium atoms release electrons and absorb positrons as cadmium atoms in the anode are converted into cadmium cations in solution, so acting an electron source and positron sink. At the cathode, copper cations in solution release positrons and adsorb electrons to deposit copper metal at the cathode, so acting a positron source and electron sink. The parallel chemical reactions at anode and cathode plates creates an imbalance between electrons and positrons and a corresponding emf across the wire connecting them, resulting in an electric current consisting of the synchronous shuffling of electrons from anode to cathode and positrons in the opposite direction.

The **Electrolytic Cell** example of figure 10b, effectively reverses the process of the Galvanic Cell. When a DC current (shown as 0.74volts from an AC-to-DC converter) is applied, it becomes an electron supplier on the cathode side and a positron supplier on the anode side of the circuit. As the axially aligned electrons are shuffled to the cathode, they are adsorbed by cadmium cations to deposit cadmium metal onto the cathode, which acts as an electron sink. The cathode also acts as a positron supplier as positrons are also released by the same chemical reaction. At the anode, positrons from the power supply are absorbed by the copper metal and electrons are released as copper cations are released into the solution: thus the anode acts as a positron sink and an electron source.

Such chemical cells demonstrate how concentrations of electrons and positrons, whether derived from chemical reactions or artificial power sources, create sources and sinks for free electrons and positrons, with the emf so generated aligning them and causing them to shuffle past each other in opposite directions as an electric current.

Electromagnetic Attraction and Repulsion: An Explanation

The table of figure 3 tabulates electric field attraction and repulsion patterns, which, in similar fashion to the descriptions and rules provided by conventional Science, provides no indication of the mechanisms involved. A similar situation of rules and no explanation applies to magnetic pole attraction and repulsion. Although not a definitive explanation, the TSE model provides some insight into the mechanics involved and the factors in play.

For a magnetic field with no electric component, such as those associated with magnets or the induced magnetic field around a loop or coil carrying an electric current (the formation of an induced magnetic field has already been explained), electrons and positrons are only involved indirectly. The flow of electromagnetic energy for a magnetic field is out from the North Pole and back in at the South Pole: the energy flow has no circular component apart from its large arc trajectory around the magnet or loop. Opposite pole attraction occurs because the out-flow and in-flow magnetic field energy join as shown in figures 11a and 11b, with the out-flow from the North pole being accelerated by the in-flow of the South pole, pulling the two together. Like-pole repulsion occurs because the energy flows push against each other as shown in figures 11c for opposing North poles: simply reverse the flowline arrows for opposing South pole repulsion.

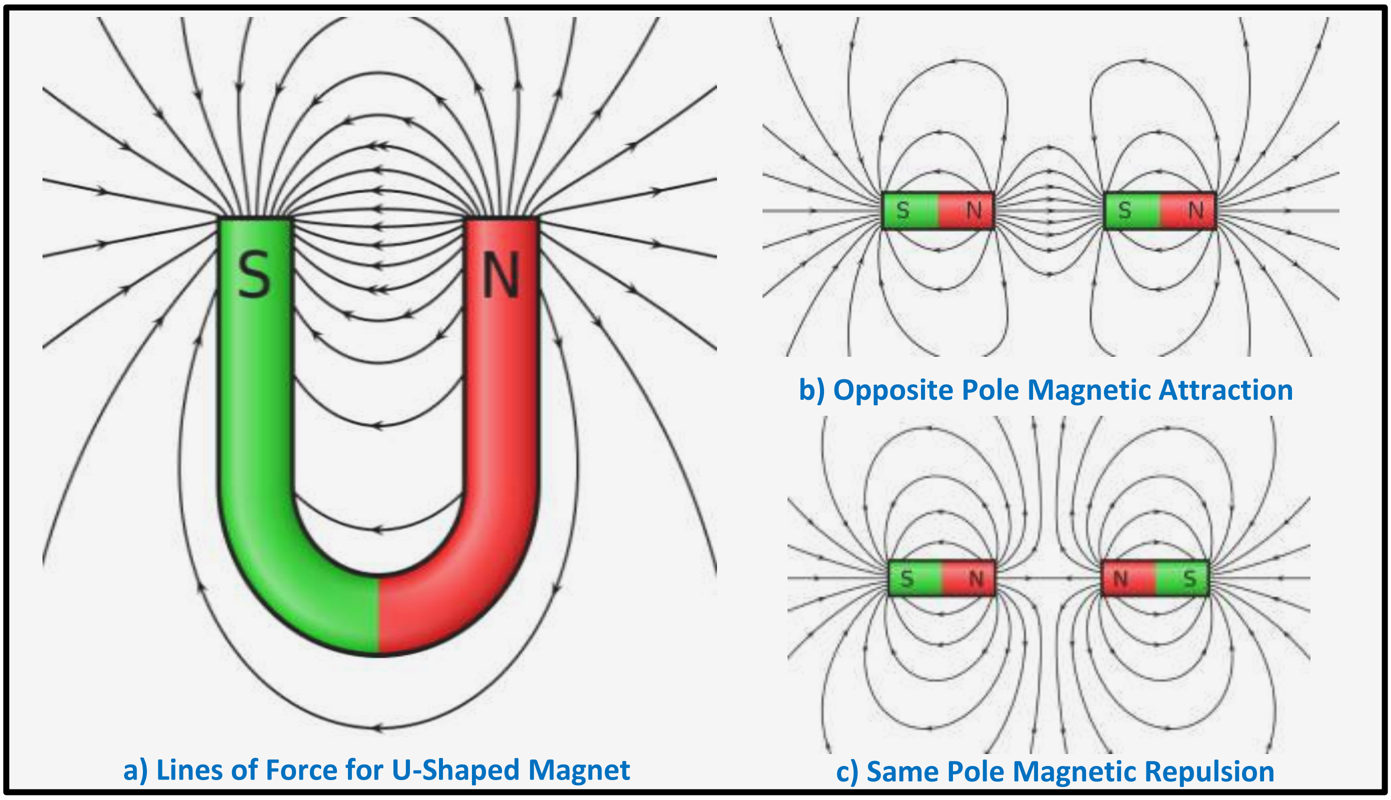


Figure 11: Opposite-Pole Attraction and Like-Pole Repulsion in Magnets

For electric fields the mechanics of attraction and repulsion are more complex because it involves swirling solenoidal energy flow patterns and poles with magnetic and electric field components; also the orientation and chirality of the electrons and positrons become important. For two monopole electric point charges as shown in figure 12, because the N- electron strand fields and N+ positron strand fields have different chirality, when facing each other the strand fields are spinning in the same direction. Instead of their central out-flow magnetic energy pushing against each other as for a pair of magnetic North pole fields, a **central buffer zone** is created (shown as green); the energy flow in the buffer zone is circular-only (in the green arrow direction). As both sets of strand fields need to maintain energy flow back to their respective South poles, the outer-return energy flows, acting in competition with each other, pull in opposite directions on the central buffer zone energy, pulling them both towards that zone: thus we have attraction.

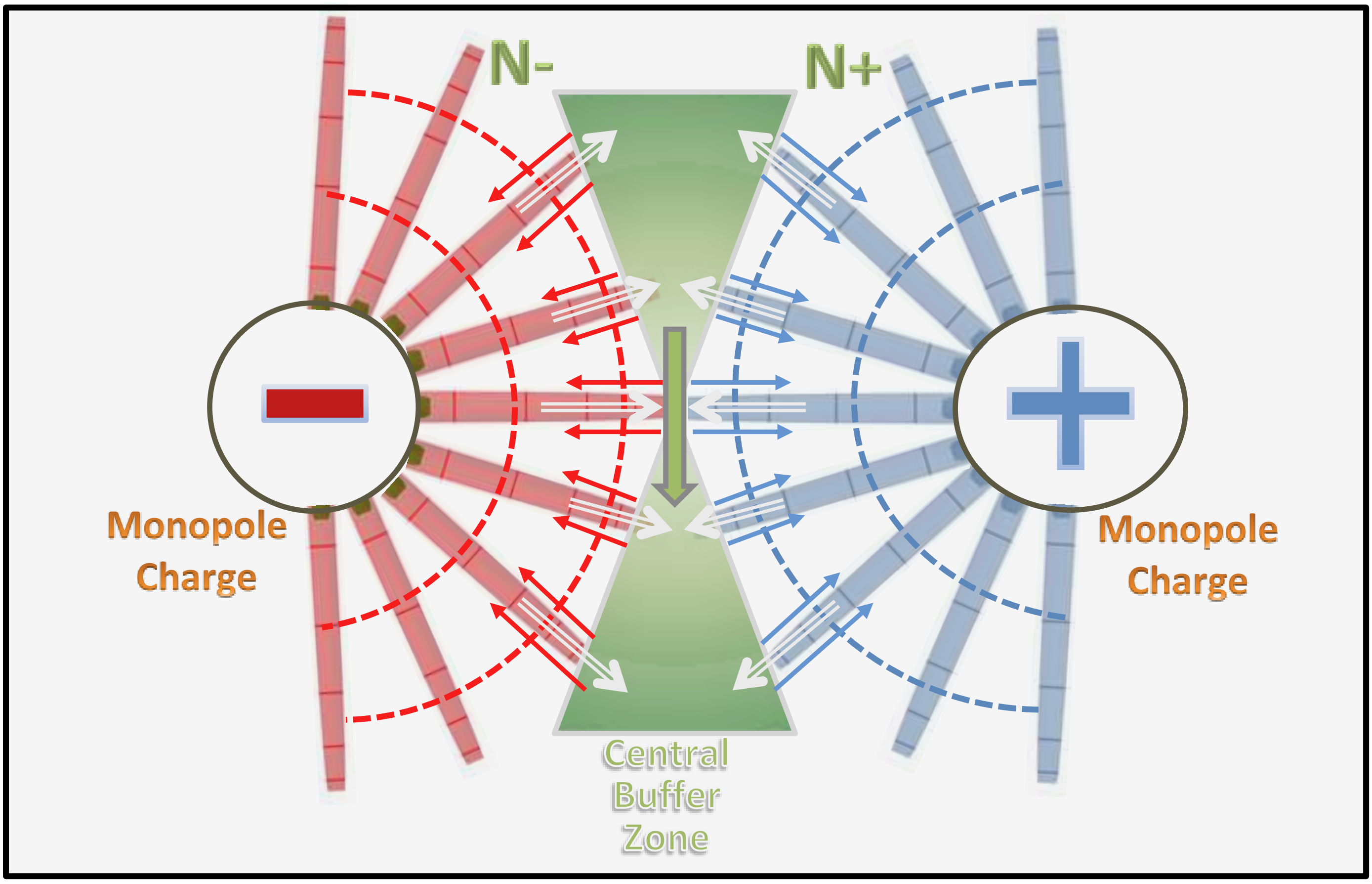


Figure 12: Opposite Charge Attraction between Monopole Point Charges

The same explanation applies to S+ and S- attraction, except that the buffer zone is created by the outer energy out-flow, with the circular flow being in the opposite direction; here it is the competitive pull by the strand fields' central energy in-flows on the central buffer zone energy that causes attraction.

Although there are more combinations (pairs of N-, N+, S- and S+ opposing poles), electron-to-electron and positron-to-positron electric field repulsion is much simpler to explain than attraction because for each of these combinations the circular flow of the electromagnetic fields oppose and cancel each other out. Thus, as for magnetic like-pole repulsion for magnets, repulsion occurs because the energy flows push directly against each other.

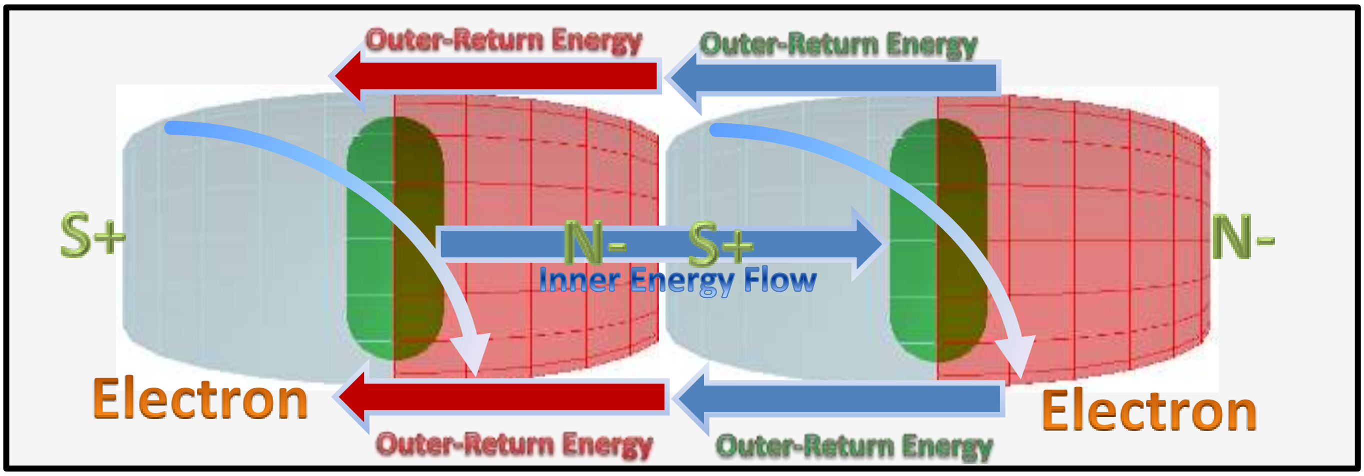


Figure 13: Energy Flow for Aligned Electrons within an Electron Strand

When the N- and S+ poles of a pair of electrons are brought close to each other end-on-end, their inner energy flows coincide and combine and their outer-flows combine and flow in the opposite direction. Referring to figure 13, the outer-flow to the left pulls the electron on the right towards the one on the left, whereas the inner-flow to the right pulls the left electron towards the right: once again we have attraction. Within electron strands, attraction between axially aligned, end-on-end stacked electrons keeps them in line with each other and evenly spaced within their strands. Similar processes apply to positrons involving their N+ and S- poles.

Electron/Positron Strands and Superconductivity

So far this paper has suggested that the electron and positron strands are continous from source to sink, but this is far from the case. In temperatures above about 170K, even the best of electrical conductors (e.g. Au) are far from perfect conductors: structural flaws (crystal interfaces and micro-fractures associated with the manufacturing process) and contaminants ensure that is the case. Structural flaws and contaminants, provide barriers that can break strands into smaller strands. Where possible, broken strands connect with other strands to build into longer strands, but the process of breaking and (re)joining strands creates energy loss in the form of heat and light, with the level of difficulty encountered by strands determining the carrier's resistance (Ω).

Usually when a metal conductor is cooled there is an increase in conductivity. With the TSE model, cooling involves the loss of energy by the atoms of the conductor rather than the loss of energy of the free electrons and positrons within strands. Energy losses of atoms within the conductor reduce the stregth of electromagnetic fields associated with them that serve to impede strand movement; their demise thus increases conductivity accordingly.

Superconductivity for **superconductive materials** commences at about 170K (164K, under 30GPa of pressure for $HgBa_2Ca_2Cu_3O_{8+x}$). The electomagnetic barriers presented by atoms in the superconductor, including contaminants, are minimised as the temperature appoaches the conductor's **Critical Temperature**. When a current is applied the electron/positron strands connect for the full length of the conductor without break, virtually unimpeded by atom and contaminant electromagnetic fields, turning it into a **perfect conductor**. In superconductor mode the energy flow ouside the strands is so strong that the magnetic flux of external magnetic fields is excluded. Even after the power source is removed, the electromagnetic fields of the conductor atoms are so weak that the free electrons and positrons within strands keep most of their axial alignment to display perfect diamagnetism (the **Meissner Effect**).

Free Electron and Positron Farming

Electrons are most commonly sourced from thermionic cathode ray tubes (e.g. first generation TV tubes): those used in research settings are usually called **electron guns**. Unfortunately, by reversing the anodes and cathodes of electron guns does not create a Positron gun because, as explained in Redefining the Electron (Part 2), positrons require much more energy in order to be ejected from matter as free positrons.

Low level concentrations of positrons can be sourced from to β+ decay and Electron Capture (also covered in part 2). One practical application of this source is **P**ositron **E**mission **T**omography (PET). PET is a gamma imaging technique using radionuclide tracers that generate positrons which trigger electron-positron annihilation inside a patient's body: the resulting pair of gamma ray travel in opposite directions, and are detected allowing the tracer locations to be accurately mapped producing a high resolution image.

Although electrons and positrons can easily be manipulated and concentrated (e.g. a Van de Graaff generator or simply rubbing a synthetic cloth against a glass or perspex rod), it is difficult to to generate larger quantities of free positrons.

One brute-force technique for generating useful quantities of free positons is to bombard a metal film with high kinetic-energy electrons so as to knock positrons out of the metal film. At CERN, the **LIL** (**L**arge Scale Electron-Positron Collider **I**njector **L**inac) uses an electron gun to assemble electrons with an energy of 80 keV; these are in turn accelerated to an energy of around 200 MeV which are then shot at a tungsten target to produce positrons that can be magnetically separated and further accelerated for particle collision purposes. This is an expensive, larger-scale operation of limited availability to a small handfull of researchers.

On a smaller scale, in their 2013 paper titled 'Table-Top Laser-Based Source of Femtosecond, Collimated, Ultra-relativistic Positron Beams', by G. Sarri et. al. report the generation of a positron beam using a laser-driven particle acceleration setup (see figure 14). A petawatt (10^{15}W) laser was fired at a sample of inert helium gas, creating a stream of electrons moving at very high speed, which were directed at a very thin sheet of metal foil: the resulting collisions produced a stream of electron and positron (and gamma ray) emissions which could be separated using magnets. This has led to cheaper, more practical setup options for researchers.

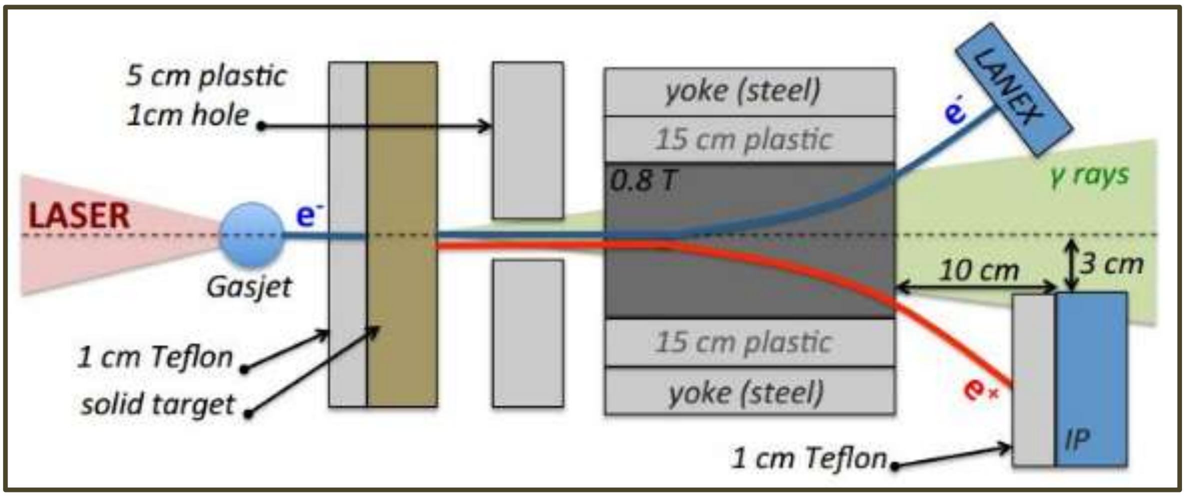


Figure 14: Laser Generated Electron and Positron Generation Setup

Summary and Conclusions

The TSE model provides logical, consistent explanations regarding the nature of electric and magnetic fields, electrons, positrons, electric current flow, electric capacitors the induction of electric current and superconductivity. It represents a new approach that has the potential to cause a major re-think about electricity that is radically different from the interpretation based upon a monopole electron, and the ramifications for all areas of Physics are significant.

The follow-up paper, Redefining the Electron (Part 2), explores how the TSE model impacts on the atomic structure and the physical characteristics of elements in the Periodic Table, molecules and compounds; and how they interact chemically with each other. It provides an explanation of how the electrons and positrons referred to in Part 1 are generated. It also provides explanations for the source and particle-wave nature of EMR, and alternative explanations for spectral line emission and absorption, the photo-electric effect, the Compton Effect, electron pair generation and annihilation, beta and electron capture radiation, plasma formation, Gravity and Gravity waves.

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