FACES OF LENR

Part 1: From Alchemy to Biological Transmutations

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Abstract

The aim of this paper is to help inventors design LENR-based devices, to make economically viable clean energy machines. In order to achieve this goal, the underlying physics is discussed. Though all LENR (low-energy nuclear reaction) processes require some form of catalytic action, they need two main forms: cold (down to room temperature) aided by "condensed plasmoids" as quasi-particles, and hot (above ≈1,000°C) with the help of intense local neutrino generation and plasma waves. Further auxiliary effects are needed to make LENR economically viable.

What is to be learned? We have to acknowledge the existence of the ether—as a sea of neutrinos and novel fields, due to rotating charges. Rotating masses may generate similar fields, as induced vortexes of ether. Further, we must acknowledge the extra macroscopic space dimension, as a consequence of the above. All in all, symmetry (continuous and discrete) and ether (as a superfluid medium and vacuum fluctuation) will be the two important fundamental ideas embedded into our extended concepts of nature.

By acknowledging the ether, a number of forgotten inventions and test results can be explained, and new devices can be designed. By extending our view of nature, biological transmutation and order in cellular organization in biology will become a natural consequence of charge movement.

Introduction

LENR is based on new, "extended" physics; this is the reason why only lucky inventors stumbled onto it as early as the 1890s. Textbooks do not help. Even if inventors succeeded in patenting their inventions, they missed important points, thus their effects are simply irreproducible.

Inventors usually operate by trial and error, and thus gain know-how. But this crucial set of data is missing from their patent descriptions. By gaining an insight into the working principles of these inventions, the reader will hopefully be better off than the lucky inventors.

The top scientists in the 1920s were helpless to communicate with Tesla or Moray, etc. No wonder.

Textbook quantum mechanics (QM) or classical physics (relativity theories), the pillars of physics, are of little use here.

The Correas, Chernetzky, Moray, Tesla, etc. hoped for a single step solution in their model—that is, a mysterious oscillating ether would be the clue to excess energy.

Not so. A tricky chain of unknown, unrecognized physical phenomena lurks behind these strange effects. They usually appear as the coincidence of outlandish parameters and counter-intuitive construction. Based on known physics they just cannot work at all. The "density of strangeness" is high both in terms of new effects and technical arrangements.

In this paper, the simplest "irreducible" setups will be used to explain a device and the effects behind them.

The Earliest Suspicion

Nearly 150 years have passed since Nikola Tesla stumbled onto the curious excess energy process of the "carbon button" discharge lamp. That was more than just a proof of principle, as he developed it to a near commercial product for lighting. The lamp comprised several new physical effects, and novel engineering inventions. It could have been a serious competitor for the incandescent tungsten filament bulbs and the later "neon tubes" of gas discharge devices.

One of the aims of this paper is to investigate the physics behind this discharge device, as arguably this is the first LENR-based device invented in the 1890s.[1]

This discovery completely escaped the attention of "Tesla fans" in the engineering community, to say nothing of (rare) open-minded physicists.

But this paper is more than just a tribute to an undervalued creative genius. The real purpose is to dig deep into the physics and engineering solutions of direct electric energy production by LENR, a lifetime quest of this author. Fortunately there has been considerable development of the physics behind LENR lately. So less guesswork is needed to outline how the carbon button lamp worked, yielding extra bright white light, with a low amount of electric energy input.

Though the button lamp cannot compete with LEDs, it was an important stepping stone to direct energy production. That is the clue to the first *real* Tesla car, by now lost in the fog of urban legends.

One aim of this paper is to concentrate on the physics and engineering solutions behind direct electric energy production devices. On the physics side, the concepts of ether, the missing rotations in electrodynamics and surface effects are discussed. On the technical side, the role of fast plasma transient sparks will be discussed, as all such inventions are based on transient constricted plasma.

We shall not review the history of forgotten LENR devices, as it was done in a four-part series in *IE*.[2] Just a casual remark about the sad history of the carbon button lamp: the hope of a commercial application sank with the Titanic, as the investor supporting the project, John Jacob Astor, drowned

on that fateful trip. The consequence of that tragedy is that Tesla lost his only remaining powerful investor.

The Carbon Button Lamp

This deceptively simple looking device is a good example of the semiconductor cathode LENR discharge device.

At first we shall have a look at the device itself, then at the physics behind it. Figure 1 shows the device, taken from the original source.[1]

What happens when the device is operational? How are its three parts (the holder, SiC cathode and the invisible anode) connected?

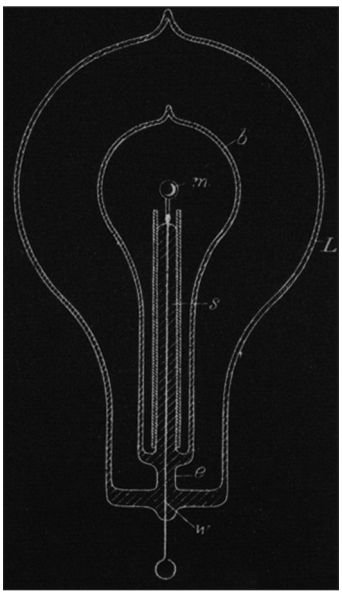

Figure 1. One layout of the carbon button lamp.[1,p270] Note the double wall structure. The inner sphere was hot.

Based on our textbook physics, the device just cannot work, as there is no closed circuit.

But Tesla invented the open, or single wire, "circuit," where the anode is connected to a capacitively coupled load, to the environment of the tube itself.

This "single wire" circuit based on polarization currents is now forgotten. (This is not by suppression, but because it does not work well.)

It is technically beneficial only for high frequency, high voltage, low current applications, that is for transient gas discharge. It is quite inferior to closed circuit power applications, like driving an AC motor invented previously by Tesla. Let's get to the details.

The spherical "button" is not carbon (graphite) but SiC, a semiconductor; this fact is crucial.

Semiconductors behave in a strange manner, barely explored even today. Semiconductor etching for chip manufacturing is a major technology, but semiconductor cathode driven intermittent, high frequency discharges are on the back burner, despite their significance.

Only a small Turkish-Azeri team investigated it with a shoestring budget.[3]

For historical comparison, there were two other simple, "irreducible" LENR devices in those early years: The spark discharge driven discharge tubes of N. Collie *et al*. at London College by 1914,[4] where transmutation of hydrogen into helium and neon was observed, and the vapor filled tubes of young T.H. Moray. (The Pons- Fleischmann electrochemical cell came a century later, where excess energy and transmutation have been observed repeatedly.)

Of the above three simple systems, the carbon button device was the best, in terms of abundance of effects and utility for further practical applications. But science, as an institution and accumulated knowledge and understanding of nature, was completely unable to grasp the significance of the apparent excess energy, and chemical analysis was not up to the job to detect transmutations on the cathode surface.

Tesla was baffled and intrigued by the bright light emitted by the hot surface of the SiC cathode. He clearly noted the unusual brightness of the device, but there is no definite experimental proof that he performed energy balance tests for any gas discharge experiments.

I quote some relevant excerpts from his writings:

> Nature has stored up in the universe infinite energy. The eternal recipient and transmitter of this infinite energy is the ether. The recognition of the existence of ether, and of the functions it performs, is one of the most important results of modern scientific research. The mere abandoning of the idea of action at a distance, the assumption of a medium pervading all space and connecting all gross matter has freed the minds of thinkers of an ever present doubt by opening a new horizon…[1,p145]

Mainstream physics later abandoned the idea of superfluid ether, though it came back through the back door as vacuum fluctuation. (We shall touch on this important issue in Part 2, when discussing the important experimental results of Alexander Parkhamov.) Tesla wrote:

> The production of a small electrode, capable of withstanding enormous temperatures, I regard as of the greatest importance in the manufacture of light. It would enable us to obtain, by means of currents of very high frequencies, certainly 20 times, if not more, the quantity of light which is obtained in the present incandescent lamp by the same expenditure of energy. This estimate may appear to many exaggerated, but in reality I think it is far from being so.[1,p258]

> The high incandescence of the button is a necessary evil, but what is really wanted is the high incandescence of the gas surrounding the button. In other words the problem in such a lamp is to bring the mass of gas to the highest possible incandescence.[1,p258]

SiC has been used ever since as a common abrasive, but recently it is used as a semiconductor in high power devices, transistors, MOSFETS, etc. So why is a SiC sphere so interesting in transient discharge?

There are two known reasons as of today:

1) A transient arc and corona discharge may generate quasi-stable charge rings or EVO (exotic vacuum object), or by a different name, condensed plasmoids (CP), etc. These nearly stable quasi-particles come in different sizes and life spans, and they may serve as catalysts for LENR. They leave clearly visible holes on metal or ceramic surfaces, and are arguably involved in very strange transmutation processes. Under polarized light (found by Bob Greenyer of the Martin Fleischmann Memorial Project), the caterpillar-like traces are quite visible, but their existence is impossible according to our textbook physics. Their traces are usually not contours, but sometimes periodic, as if they were oscillating in and out of our space-time.

The massive, toroidal structures may have an electric charge as well, and thus would be capable of charge screening, consequently to catalyze fusion (maybe fission as well) among neighboring nuclei.

Electron muons (heavy electrons) do just the same in liquid deuterium, catalyzing fusion, as the nuclei come close to each other, due to the heavy mass of the muon. (More about the details of formation and quasi-stability of the condensed plasmoids much later…)

As of today, the exact criteria to form strange quasi-particles is far from being complete, but a wide variety of currents in plasma and pulse duration may yield condensed plasmoids. See, for example, Lutz Jaitner[5] and the video presentation of Bob Greenyer of MFMP (quantumheat.org).

The existence of these toroidal charge clusters is not well known even in the small LENR community, as the concept of stable quasi-particle is alien to nearly all electrochemists.

In order to have any practical use for them, one must move them by external fields or mechanical oscillations; otherwise they just sit and wait for neighboring nuclei to catalyze. But this is essential only for the technical applications not for its formation.

2.) Surface-bound charge waves, charge clusters. The unexpected utility of some semiconductors is that they generate high frequency (in the order of THz) surface charge oscillations, when triggered by external electric fields of much lower frequency (like the Gunn diodes, now out of favor).

When there is a plasma above such an oscillating crystal, the local electron waves on the surface do polarize the plasma above the surface. Thus very high frequency plasma waves are generated, and both the electrons and protons behave like waves of high mass, charged particles. They are plasmons—polaritons—a known and accepted fact in mainstream science. However they are usually generated above thin layers of good conductors, usually gold, but not above semiconductors.

The beauty and utility of this fact is that both processes may take place hand in hand at the same time.

The electron waves have extreme charge density, and thus electric field intensity, several million V/cm of field intensity. This is also enough to catalyze fusion not only among light nuclei, but among heavier nuclei. However, there is a catch: the spatial dimension of the semiconductor is important. A single, small crystal, zero-dimensional dot is the best for resonant charge wave formation.

A loose bunch of crystals may do this trick. A thin one-dimensional wire made of a semiconductor is also a good site, but there is no such device now, off the shelf.

A flat plane spreads the excitation energy, and the charge wave vanishes practically immediately. So preparation of the sample is very important. Know-how or sheer luck is decisive. There is no information at all about how Tesla prepared the SiC sphere, what the grain size was or how they were glued together. It was definitely a polycrystal, of unknown crystal size distribution and adhesive material.

According to mainstream science, the formation of vortex-like permanent structures in ionized plasma is strictly ruled out. There are simply no forces to make them, regardless of their size. A spark or arc discharge will be constricted and squeezed. This "pinch" effect was hoped to facilitate controlled hot fusion in the 1950s. (It failed, along with several similar schemes without catalysts.)

A Hidden Symmetry

Now we have reached an age-old problem of physics—symmetry. While lip service is given to the subject, it is never put to use in practice. The most blatant situation is within classical electrodynamics.

Contrary to classical mechanics, there is *no room for rotation in classical electrodynamics*. Only static charges (E electric field) and linear charge movement is allowed (B induction field). Not even the vector potential is considered a real field. There is no rotation, that is angular velocity of charges, in Maxwell's equations.

One disturbing lack of symmetry is apparent though: the *lack of magnetic charge and magnetic current*. This is not due to lack of effort, but a magnetic charge was expected to appear as an elementary particle. In due course, magnetic monopoles were found, but as pseudo-particles of rotating, electric charge carrying tiny droplets, suspended in a gas. These were found by the maverick Felix Ehrenhaft, a professor of physics at the University of Vienna, in the 1930s, but ignored. They had an apparently very high angular velocity, and they did behave as magnetic monopoles.[6]

Despite repeated successful tests in the 1970s by V.F. Mikhailov,[6] mainstream physics still completely ignored these results because they were not *real* permanent elementary particles, with a charge predicted by P.A.M. Dirac.

The essence of this problem is this: as electric charges move at a very slow pace in a conductor (on the order of 0.02 μm/sec for a current of 1 A/cm^2), even in the case of a small coil of 1 mm diameter, the angular velocity of the current is negligible and never apparent.

But with a high vacuum or even in dense plasma, the charge carrier may have angular velocities 5 to 15 orders of magnitude higher! Therefore rotation effects may (and will) appear in transient plasma or in rotating electron beams, like in magnetrons, for example.

The experimental base of electrodynamics was laid down by Ampere, Faraday, Hertz, etc. in the 19th century, in copper wires, with little freedom to move. There is much to learn about how it happened.

Electricity: A Brief History of Blunders

Electricity was known to the Greeks and Egyptians, from rubbing a piece of glass or sulfur. With the Leyden jar, it was even possible to store it. But when Luigi Galvani started to play with frogs' legs, he was scorned. Alessandro Volta did achieve the unexpected: two different (asymmetric) pieces of metal electrodes were necessary to create a "Voltaic pile," a constant source of electric force and current. He essentially re-discovered the "Baghdad batteries."

By then it was an established fact that electricity has nothing to do with magnetism. Yet an outsider, Danish Prof. H.C. Oersted, had his doubts. He expected that wires had magnetic fields along the conducting wire. For eight years he tried and failed over and over. One of his students realized that a compass needle moved when it was above the wire. It turned out the magnetic "field" was a vortex around the wire. Oersted thought it was due to the heat. It happened only when the wire was white hot due to high current. (Simply, his magnetic needles and iron filings were at the wrong place and not sensitive enough.)

Andre M. Ampere expected magnetic attraction to appear between solenoids. The force between straight wires was incomprehensible to him, as he saw magnetism as a result of rotating electricity in coils.[7] He missed induction, as he did

not expect to find it.

Faraday also missed transient induction for eight years. He expected current generation for direct current. He had a compelling logic though.

As DC current magnetized a steel rod when placed inside a solenoid, the reverse seemed logical. When a permanent magnet rod was placed into the same solenoid, DC was expected. It never happened—only while pulling out of the solenoid.

The fact of transient induction, that the electric vortex is due to a changing magnetic field (rot $E(t) \sim \partial B(t)/\partial t$), was a real shock, and unexpected.

Even the concept of electric and magnetic "fields" as real objects in nature was rejected, ignored by contemporary scientists (but not censored), as action at a distance is spooky. Only contact forces are real!

Maxwell's displacement current was met with the same skepticism. He expected changing electric fields would create magnetic vortexes, *e.g.* between the capacitor's plates in oscillating circuits. It was a logical analogy of induction, rot $B(t) \sim \partial E(t)/\partial t$.

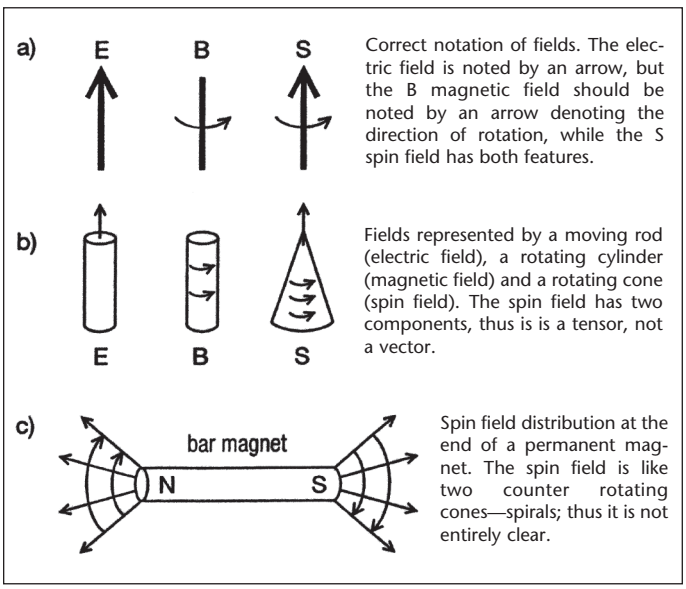

Figure 2. a) An electric field line, as a polar vector. Its source is a static charge. b) A magnetic force field line, as an axial vector. Its source is a charge current. c) A spin field surface, characterized by two components, a tensor of second rank. Its source is a rotating electric charge.

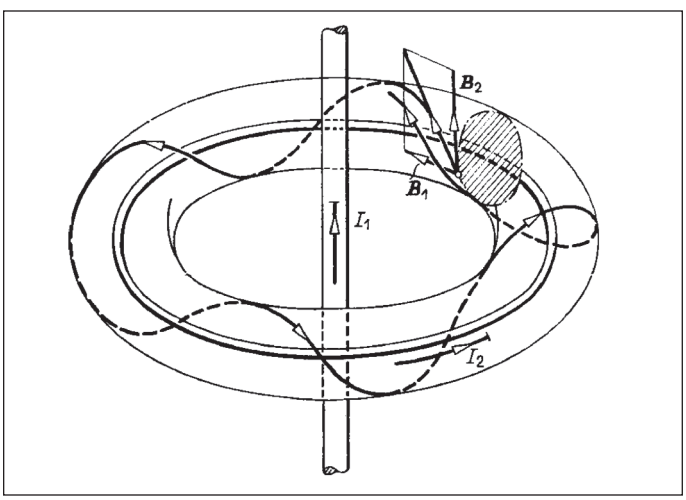

Figure 3. A simple sum of a straight and a loop current has a strange magnetic field; it is no longer closed.

Despite his best attempts, all of Maxwell's experiments failed to prove it, and magnetic vortex fields never appeared.

It was a practical problem though. The energy density of electric fields in air is less by several orders of magnitude than that of the steel horseshoe magnets. Detection of transient magnetic fields was off limits, although Rowland had shown that there is a weak magnetic field around moving charges!

Decades later, Hertz made indirect experiments by creating GHz electromagnetic waves.

All accepted, known terms of classical electrodynamics were met at first with ridicule at best or open hostility at worst, as all effects went head on against the logical framework of classical mechanics, the "real physics." Maxwell's mathematical formulation of complex quaternions made the study of fields even more difficult. Heaviside's eye-catching vector formalism appeared decades later, also amid utter skepticism and scorn.

We may think that there would be a happy ending after all, as expected in a Hollywood movie. Not at all.

Electrodynamics was formed with lead acid batteries, and sizable copper wires, with limited freedom of movement.

This inhibits the study of rotating charges, as their quoted speed is about 0.2 μm/second for a 1 Amp current in a 1 cm^2 copper conductor. Somewhere around a 1 μm diameter wire, with a solenoid diameter of 5-10 μm, can yield an appreciable angular velocity at about 100 Amps for a fraction of a second before melting the wire.

So to study rotating currents with traditional copper wires is difficult, bordering on the impossible, due to technical limitations.

Transient plasma studies appeared much later but there was no interest or intellectual curiosity to study anomalies in plasmas.

The Missing Rotation in Electrodynamics

Textbook electrodynamics is based on fields, charges and currents, that is, fields with sources and without sources, or vortexes. It is a familiar set of concepts by now, based on vectors. But this traditional view is incomplete for several reasons, if symmetry is concerned. Magnetic and electric field vectors are usually characterized by an arrow. While this is a correct symmetry for the electric field, it is not for a magnetic field, which ought to be characterized by an axial symmetry, by a rotating field line, either left or right. (See Figure 2a and 2b.)

Electric fields may have two sources: charge distribution, or changing current (in time). Electric field lines may have a source and a sink while magnetic "field lines" may have a source only in a magnetic monopole, otherwise it is "always a closed loop."

But this common textbook allegation is plain wrong. In the setup of Figure 3, magnetic field lines are open; they end in infinity. The magnetic field lines of the ring current loop are open but they have no source either!

Let's talk about the rotation of charges in a vacuum and in ionized gases, and later in materials, as we must let charges rotate, and low pressure plasma is the best means for it.

It is known that each symmetry in an electric charge movement has its own field.

A static charge is the source of an electric field (represented by the symmetry of a sphere). A moving charge generates a magnetic vortex field (represented by a rotating cylinder with less symmetry than a sphere). By decreasing the charge movement symmetry further, we rotate it. Thus a rotating charge must have its own field, again with new properties! Let's name it a spin field.

While electric and magnetic fields are characterized by attracting (or repulsing) forces in a steady state, spin field has a torque and attraction or repulsion as well. (See Figure 2c.)

Technically we cannot generate a static spin field with a copper wire wound as a loop or solenoid due to the slow diffusion speed of electrons, as discussed before. In practice, it is nearly a futile effort to generate a spin field by wires with our present technical level.

Just look at the differences in classical electrodynamics. Two static sources, let's say 1 Coulomb charges from a distance of 1 meter have such an extreme force, that it can tear apart a rock hill.

Two wires, each 1 m long carrying current of 1 Ampere for a distance of 1 m, have a mutual force of a fraction of a Newton so even a mosquito may handle it.

Two loop currents of 1 m in diameter, each having a 1 Ampere current from a distance of 1 m (see Figure 4), have a similar "step down" in torque, which is hopeless to measure.

This author witnessed the rotation torque effect while observing the cathodes of Correa and Chernetzky devices. There was a regular circular molten crater at the cathode under transient arc discharge spots. The rotating molten metal was spread tangentially, not in a radial path, as expected. Correa noted it first, but took it as an action of ether. During the short anomalous glow-arc transition period, there was a curious spherical, swirling plasma arc at the cathode, about 1 cm diameter (see *IE* #9, 1996, p. 35). However, in a steady-state arc discharge there is no rotating ball-like plasma at the cathode.

Textbook physics predicts only pinch forces, pulling the plasma together, but this was a vortex effect, spinning the discharge. The same effect took place at the Chernetzky cathodes. There was no such effect for steady arc discharges.

In biology there is a strong static source of spin field in all living beings. Humans have trillions of mitochondria. In each of them there are thousands of rotating enzymes (a true wonder of nature!) driven by rotating protons. These nanomotors rotate around 6,000 rev/min to produce ATP, the universal fuel of life on Earth. These nanomotors drive "simple" bacteria and us as well; they are universal. We shall discuss this problem along with biological transmutation because this is the suspected environment for LENR.

Indeed, there is a strong torque field around us, detectable by a balanced rotating wheel, with a needle bearing. (This is the vitality meter or Egely Wheel, developed by this author.) Having seen this static torque field around us led this author on a quest to find its nature and its source.

Our present industrial technology is simply no match for nature, as the thinnest wire (15 μm) wound in a tight solenoid (say 20 μm) carrying 1 Ampere is the best we can do today. (See Figure 5; coil is made by this author.) It is still ridiculously far from nature's capability.

Modeling Rotation of Charges

Learning physics give us a model of nature. Two kinds of matter are known at present: substance with mass and fields. The rotation of charge-spin is murky at best. Fields due to rotating currents with a specific angular velocity are not considered, not even mentioned in either classical and QM textbooks.

Classical mechanics involves rotation in a straightforward manner. Electrodynamics suspiciously ignores it. But all biophysics textbooks discuss the uniform, left-handed chirality of organic matter (proteins, lipids and sugars).

Most probably this lies at the root problem of not expecting LENR, apart from having an incorrect concept of the structure of nuclei.

Let us see why classical mechanics and electrodynamics have different levels of depth in understanding nature at the macroscopic level.

It is about the treatment of rotation for matter and charge. A pendulum, a simple oscillating system in general, is the workhorse of physical concepts.

A mathematical pendulum considers kinetic and potential energy of an oscillating mass point. (A mass-spring system is even simpler.)

In a physical pendulum, the oscillations of a distributed mass are investigated. Angular velocity and moment of inertia are introduced. The torsion pendulum is a further extension of this system, doing away with gravity.

Angular velocity and momentum vectors are introduced as rotating pseudo-vectors, having different symmetry reflexion properties from axial vectors like: force, velocity,

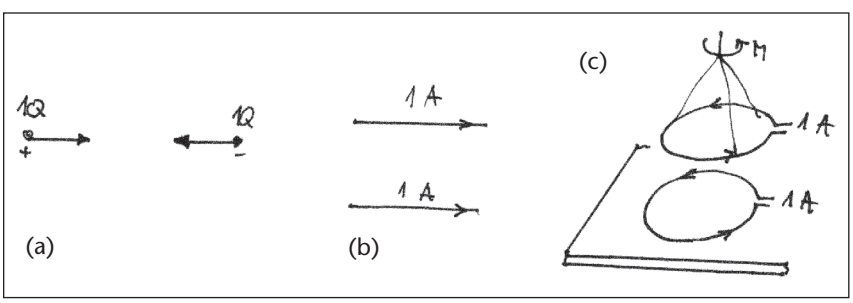

Figure 4. (a) Coulomb forces are high at unit, 1 Coulomb charges. (b) Forces between 1 Ampere currents at 1 m are on the order of 10^{-7} Newton. (c) Torque between two loop currents due to spin is very low.

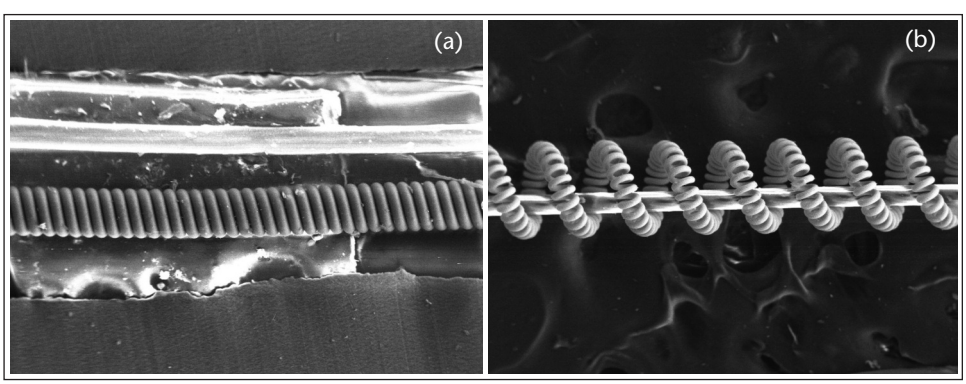

Figure 5a-b. Home-made 20 μm solenoids.

acceleration and space vectors.

In nutating gyroscopes, three independent angular velocities interact. Instead of the concept of mass, the moment of inertia is used for a rigid, rotating mass. Mass is generalized to a tensor of second rank. It is a far cry from the scalar mass of a mathematical mass point, so rotation as a concept brings with it a number of generalizations.

In electrodynamics we are still at the shallow level of mathematical pendulums.

Precession and nutation as movements of gyroscopes are counter-intuitive and an unexpected sort of movement—due to the freedom of three-axis (triaxial) rotations. Such symmetries do not exist in QM or in "classical" electrodynamics. So when they do happen in biology, they cause unanticipated bizarre effects, censored as "paranormal" effects. Physics is sometimes weird because our intuition and expectations are false. Intuition is formed in our everyday world, but the "everyday reality" is quite different down at the level of molecules.

The concept of symmetry is the most fruitful in nature, as it points toward uncharted areas, like unexplored effects of rotating charges.

This author found only three inventions where electric charges concentrated on a surface were rotated intentionally, yielding excess electric energy:

1) The Swiss Testatika (Mathernita) of Paul Bowman, a modified Wimhurst machine, based on electrostatic influence.
2) W.W. Hyde. U.S. patent 4.897.592,1990 is also an influence machine, working at ≈3 kV and over 1,000 rev/min. Similar suspicious U.S. patents: 2.522.106, 3.013.201, 4.127.804, 4.595.852
3) The Russian antigravity/overunity invention of V.V. Roschin and S.M. Godin, Russian patent 2,155,453, published on August 27, 2000 (a Searl-type device). Test results are discussed in detail.[8]

All these inventions along other transient discharge LENR inventions will be discussed later in the third and fourth parts of this paper, when the physical fundamentals have already been clarified.

Rotating charge experiments were carried out by Rowland in 1887, Roentgen (1888) and Eichenwald (1903) to demonstrate that macroscopic convection electric currents do have magnetic fields. There are very severe technical limitations on maximum surface charge density and angular velocity. Thus the expected value of the magnetic field is low, much less than that of the geomagnetic field, so even if the theoretical concept of a torque-carrying spin field is born, this is the wrong technical environment to find it.

Rowland and others did not expect more than a steady magnetic field, thus they were unable to find further effects of rotating charges.

Moreover, detailed books on physics do not mention the missing rotation in electrodynamics, like: J.D. Jackson's *Classical Electrodynamics*; *The Feynman Lectures on Physics*; I.V. Saveljev's *Physics: A General Course* (and thousands of other books on physics).

This important missing symmetry is not even discussed in books about symmetries, like: Wigner in his papers about symmetries; Weyl's *Symmetry*; Rosen's *Symmetry in Science*; or Roger Penrose in his monumental book *The Road to Reality: A Complete Guide to the Laws of the Universe*. In Penrose's book is a good example of the mindset of a brilliant theoretical physicist: completely detached from the real, tangible world.

We are not better off with biophysics textbooks either, where rotation of charges is mandatory. (I shall not bother readers with their shortsightedness.)

I shall refer to some important papers suggested for reading. "Dead end" references are just casually mentioned, and not fully referenced. They are noted just to indicate concepts of symmetry in theoretical physics are quite far-fetched from nature, from reality.

Also, there is not a word on the need for rotating charges in books about the fundamentals of physics: Guillen's *Five Equations that Changed the World*; Speyer's *Six Roads from Newton*; Spielberg and Anderson's *Seven Ideas that Shook Physics*; R. Newton's *What Makes Nature Tick?*

What really hurts is that there are long books on nothing but symmetries which shun rotation of charges, such as: *Symmetry in Science & Art* by A.V. Shubnikov and V.A. Koptsik or *Electromagnetism: Path to Research*, edited by D. Teplitz.

Even mavericks like Eric Laithwaite (researcher in gyroscopes, antigravity and biology) shun rotational electrodynamics.

Yet for LENR, both rotating charges and ether are important. No wonder that it is so unexpected, an out of the mainstream mindset concept! However, we shall concentrate on experiments; the theoretical will be described just to outline the modeling of rotation and ether effects.

The Eight-fold Path to Grasp the Details of Charge Rotation, LENR

In this paper we shall continue a discussion of charge rotation along the following paths:

1. Analyze strange, energy-producing inventions like Tesla's carbon button lamp, etc. and the above-mentioned three inventions.
2. Find meaningful answers (research papers) about the nature of spin, electric charge and intrinsic magnetic moment.
3. Analyze the *meaning of catalytic fusion*, and how it takes place. We start from muon catalyzed fusion of liquid deuterium. What is the meaning of charge screening? Why is n+n fusion not observed?
4. Grasp the meaning of neutrinos, and ether, in LENR processes along Parkhamov's ideas.
5. Look for forgotten experiments about the nature of rotating charges, like those of Felix Ehrenhaft, F.V. Mikhailov, P.G. Sigalov and others.
6. Find an answer about the connection of rotating charges and rotating masses, the meaning of gravity, inertia and their manipulation in forgotten or overlooked experiments and patents.
7. Follow symmetry principles, look for unexplored ones based on rotating charges and masses, design new experiments and discuss forgotten experiments.
8. Watch biology, as a storehouse of the most sophisticated technology and advanced applied physics, along principles of symmetry.

The Extended Equations of Electrodynamics

In practice, it is much easier to generate a spin field in a tran-

sient manner, in a medium where charges have higher mobility than in wires—in plasma! (In practice, electrons do rotate in a magnetic field in a high vacuum as well, but their mutual electrostatic repulsion severely restricts current density according to the hands-on experience of the author.)

In plasma, electrons and ions compensate each others' electrostatic fields. Ions (protons) are slow to move compared to electrons. This asymmetric mass relation, thus mobility of charges, makes it possible to generate spin fields in fast transients, that is in sparks with modest technical means. (We shall describe them soon.) Keep in mind that nearly all excess electric energy inventions are based on transient sparks, that is, weakly ionized self-organized plasma.

The formal extension of classical electrodynamics to include rotation is quite straightforward. At first, only one axis of rotation is considered. A loop current is the source of the spin field in a vacuum. To begin with, we shall look at three field sources in electrodynamics. We start with a familiar one: div $E = \rho_e$ that is the source of an electric field is an electric charge.

Here comes the first big problem. There is nothing about the inner nature of electric charges in thick books on electrodynamics. Why is it an inexhaustible source (or sink) of an electric field? Why is charge quantized? What is the meaning? Why does it have spin and inner magnetic momentum and what is the meaning and the physics behind the spin? Does it have a real rotation and if so what rotates? Is it matter or a condensed field? Is an electron (proton) a point singularity or does it have a meaningful size? Textbooks simply skip these problems. What are we to make of muons and tauons which are identical in any other parameter with the electron, but more massive by a factor of 200 and 3,500 times? Why do they have their own neutrinos when decaying?

These particles came unexpected to physics. E.P. Rosenbaum wrote in *Scientific American* (July 1957): "The muon was the unwelcome baby on the doorstep, signifying the end of innocence." Isidor Rabi asked: "Who ordered that?" Abdul Salam wrote in 1958: "We don't know any good reason why it should exist, nor do we know why it should have such a large mass."

I have poured through hundreds of thick books and thousands of papers, without answers. Authors just skip this embarrassing issue. Only Richard Feynman briefly addressed this problem, admitting frankly that there is no answer.

The problem is that without answers to the simple questions above, there is no way to make physics "bottom up," that is, from scratch. We can't assemble a neutron from protons and electrons, and thus form nuclei. Do strong and weak interactions follow from the known properties of elementary particles?

Apparently, not, because N. Cook and V. Dallacasa[9] argue that in fact Ampere forces hold together the nuclei in a lattice-like structure. Kovács *et al.*[10] argue at length that fields and sources have the same roots, and are not separate entities suggested in all classical electrodynamics books. Without these sure answers, we don't know why electrons don't fall into the nuclei, which every student asks as long as they are not lost in mathematical formalism.

Hans Ohanian tries to answer: "What is spin?"[11] by saying it is an angular momentum generated by a circulating flow of energy in the wave field of the electron. Andre Heslot[12] gives an answer within the framework of classical mechanics, without relativistic quantum mechanics. J.P. Wesley[13] describes it as a charged spinning ring, and gets correct values for the gyromagnetic term as well.

The Magnetic Field as Vortex

The next term is the source of the vortex magnetic field, that is, a current: rot $B = \rho_e \cdot v$, where v velocity is the drift of ρ_e electric charge density.

The vortex nature of B magnetic induction is a fact, but it has no analogy in mechanics. The fact that B "force lines" rotate and have different symmetry from E "field lines" is not always mentioned.

In textbooks about practical engineering, the difference in symmetries is not mentioned, as within the framework of typical (that is, "classical") electrodynamics, it has no significance. Thus the only source of a magnetic field is a current. For physicists, E and B fields are interchangeable by Lorentz transformation with a proper framework, and coordinate system.

For engineers, the two fields are worlds apart. Batteries and condensers are not to be mixed with coils. (Moreover, electrets are not exchangeable with permanent magnets.)

Oersted's discovery that there are circular magnetic vortexes around live conductors came as a surprise. Decades later, Ernst Mach was shocked to realize this absurdity. Why is a circular, vortex-shaped axial magnetic vortex-like field generated by a current in a wire? The current has polar symmetry—an arrow—while the magnetic field is circular, vortex-like and perpendicular to it. Is this a blatant violation of symmetry, or does a "hidden symmetry of the charges" appear in the magnetic field? This issue is never raised in the textbooks because the nature of electron spin is not discussed; it is omitted! (These are typical questions you wanted to know but were afraid to ask at school.)

So the circular, vortex symmetry of a magnetic field is an accepted fact, but its cause is not known. Some people argue that (magnetic) vector potential is oriented along the wire, as a polar field, but as B = rot A, and the field lines became circular. But this is only a mathematical argument.

Magnetic Charges

The big difference in opinion comes with magnetic charges and magnetic currents. This problem is as sensitive, problematic and divisive as the nature of intrinsic spin.

In all textbooks, div $B = 0$, that is there is no source of a magnetic field as a particle, and the magnetic current term is also missing. Detailed theoretical treatises completely avoid even mentioning this stunning asymmetry (like Landau-Lifsitz, *Theoretical Physics*, Vol. 2, Classical Fields). Feynman also skips this issue, when summing up the whole of classical physics; as Maxwell's (Heaviside's) equation, and the Lorentz force (whose weird nature is not mentioned) plus Newton's $F = d(p)/dt$, and "static" gravity law, $F = G(m_1 \cdot m_2)/r^2$. (Further: Why are these equations linear?)

In a two-volume 1979 textbook on symmetry (J.P. Elliot and P.G. Dawber, *Symmetry in Physics*) not a sentence is devoted to this obvious asymmetry.

As another example, Ian Lawrence (*A Unified Grand Tour of Theoretical Physics*, Physics Publishing, 1990) avoids the magnetic monopole issue, but mentions non-Abelian gauge theories, which is relevant for us, as we will discuss later.

F.W. Hehl and Y. Obukhov frankly address this problem right in the beginning of their book (p. 3, *Foundations of Classical Electrodynamics*, Birkhauser, 2003):

> Magnetic monopoles are alien to the structure of the axiomatics we are using; a clear asymmetry is built in between electricity and magnetism...
>
> This asymmetry is characteristic for and intrinsic to Maxwell's theory. Therefore the conservation of magnetic flux and not that of magnetic charge is postulated…
>
> The existence of a magnetic charge, in fact, would have far reaching consequences, electromagnetic vector potential A would not exist.

And a very interesting side note with small letters:

> Our arguments refer only to Abelian gauge theories. In non-Abelian gauge theories the situation is different. There monopoles seem to be a must, at least a Higgs field is present…

The reader may feel at this point that we have become distracted from LENR, and condensed plasmoids or "exotic vacuum objects." Not at all!

It is apparent that condensed plasmoid impacts have a definite circular symmetry. The pictures of Matsumoto, Shoulders, Savvatimova, Greenyer, Lewis, Urutskoev, Bostick, etc. all have circular symmetries.

Condensed plasmoids are associated with LENR either as a direct cause, or as a catalyst.

The circular symmetry of CPs are associated with rotating electric charges. Thus LENR is associated with rotating charges, and it is *outside the realm of textbook electrodynamics*. This may be the main reason why LENR is so outlandish and unexpected. *This is the reason why we must understand the relation of electrodynamics with rotation.* But it is a short detour to get to the bottom of symmetry operations.

The Curie Principle of Symmetry Reduction

Pierre Curie, a notable physicist and crystallographer, made a significant contribution to symmetry operations, notably the superpositions of symmetries. This principle is useful to predict new phenomena. It is based on the fact that different objects and/or effects have different symmetries. Their combination yields a new effect, where only that symmetry remains which is owned in each object or effect at the beginning. For example, heating, squeezing crystals, putting electric charges through them will yield cross or reduced symmetry effects, which are nevertheless new and useful. This operation is termed induced symmetry superposition, or symmetry reduction.

Let us see first how vortex rings (smoke rings) are created in fluids, with rotating (not static), toroidal symmetries. In order to create such a quasi-particle, a cylindrical drum is created, with a small diameter exit hole at one end, and a flexible membrane on the opposite bottom. When the membrane is suddenly hit, a vortex ring will leave the exit hole. (In principle the shape of the exit hole can be irregular as well).

The rotating smoke ring will bear the common symmetries of all initial causes:

1) When the exit hole is circular, the "smoke ring" or vortex line will preserve this shape (or whatever shape, but circular is the most stable).
2) The whirling of the ring is due to the rotation within the hydraulic boundary layer during the exit pulse. There is no such effect in ideal, non-viscous gas or fluid.
3) The finite size closed toroidal ring is due to the temporal break in symmetry, the "on-off" periods. The ring is not formed in a steady flow, despite the presence of the first two conditions. (Condensed plasmoids are formed along similar principles, but the details will be discussed later.)

The final symmetry of the vortex ring is induced by the deliberate combination of spatial and temporal reduction of symmetries. It is even possible to form a rotating flow, which rotates around both axes, by inserting fins into the exit hole in the tangential direction.

These quasi-particles are surprisingly stable, carry linear and angular momentum and energy. They may interact with each other in a mutually attracting and repulsing manner, exhibiting "pseudo" charge features. These emerging features are important for our further discussion of extended electrodynamics and non-commuting effects. As in a vortex ring, two distinct velocities (angular and linear) may also appear. A gas is needed for a smoke ring, and maybe ether is needed for the fields of electromagnetism.

The axial type angular velocities can be added as vectors, and they can be added regardless of their sequence. But the position of a point on the surface is no longer commutable. This feature will be important and weird, counter-intuitive in the extended electrodynamics. All inventors have stumbled onto it by luck only.

Note that vortex rings don't have to be closed if they end up on a solid surface (or liquid surface) like "worm holes." The dynamics of these Helmholtz vortexes are discussed in the detailed book Mehanika Zhidkosti by L.G. Lojcanskij (in Russian, 1950). There is a brief description of vortex filaments in Feynman's lectures, and T.E. Faber's book *Fluid Dynamics for Physicists* (Cambridge University Press, 1995). Discharge plasma physics books do not touch plasma vortex formation or filament formation.

At this point there are already three areas missing in textbook physics, which are essential to grasp condensed plasmoid formations, thus a huge portion of LENR. These are the following:

1. The physical meaning of an electric charge and its spin is murky.
2. Rotation is missing in Maxwell-Heaviside electrodynamics.
3. The symmetry reduction principles of P. Curie are unknown in plasma physics, therefore the means of formation and behavior of quasi-particles are not explored.

The above triple problems make the study of quasi-particles, and thus catalytic LENR inventions, difficult.

As long as physics is still considered an experimental science, the study of symmetry operations is essential. Symmetries are dealt mostly with gauge and group theories, but these failed to anticipate the formation of condensed plasmoids and quasi-particles in general.

It is tragic how detached theoretical physics is from nature, and especially in the area of symmetries, and electrodynamics. For them test data and observations are no longer the king. For them test data are an annoyance to discredit pet ideas.

Joe Rosen mentions Curie, for example, only as a side note (*Symmetry in Science*, Springer, 1995). Nobel laurate L.M. Lederman mentioned P. Curie only concerning radioactivity in his book (*Symmetry and the Beautiful Universe*, Prometheus Books, 2007). The same superficial two sentence treatment is found in the detailed book on rotation by W.J. Thompson (*Angular Momentum*, Wiley, 1994).

There are two exceptions, fortunately. I. Hargittai and C.A. Pickover edited a multi-faced popular account (*Spiral Symmetry*, World Scientific, 1992), where A. Lakhtakia discussed the electromagnetic theory of chiral media, missing in most theoretical books. The best insight about the meaning of symmetry is given by I. Stewart and M. Golubitsky in *Fearful Symmetry* (Penguin, 1992).

Mind the Gap!

If the enigma of biological transmutation is to be understood, we must solve the above-mentioned problems, addressed later in detail.

Today there is an enormous gap between textbook physics and the physics of life, as the latter is just crammed with unknown phenomena, like forming a highly organized structure from a high entropy, chaotic environment.

The physics of life is teeming with rotating charges, chiral medium, multiple wound "coils." Thus it is way off the beaten path of even advanced theoretical physics treaties.

The same applies to LENR. The circular structure of condensed plasmoids clearly points towards rotating charges of high angular velocities, also outside the realm of textbook physics.

These common roots point toward a common cause: life and LENR can't be grasped without rotating charges, and not just electric charges but quasi-particles as well.

Apart from the distance between the rotationless electrodynamics of textbooks and biophysics books, the technological gap between life and our present (modest) industrial high tech is apparent.

Our present theoretical physics has borne no fruit in the last 50-odd years, as it is not built on hard evidence of observations (*e.g.*, life) but on the soft sand of useless but fanciful theories.

We shall now continue our journey to the extension of electrodynamics.

Rotation and Magnetic Charges

A magnetic charge doesn't exist in nature as a "real" elementary particle, in the sense of an electron or proton. It does exist, though, as a quasi-particle. It was found by Felix Ehrenhaft while trying to measure the charge of electrons on oil droplets. When he shifted to iron droplets made with sparking iron wires, he realized that they were not dipoles like magnet needles, but monopoles—since monopoles move in homogeneous fields and dipoles don't.

A micrometer-sized iron droplet has its own magnetic field, which will precess when a homogeneous external magnetic field is switched on. When this droplet is illuminated, photo ionization may take place; one electron will be adsorbed or detached. Thus a third axis of a magnetic field appears due to the static charge and thus a new magnetic moment may appear. The nutating, rotating iron droplet reduces all its symmetries until no further symmetry reduction is possible.

This is a magnetic monopole, but not as elementary particles, as expected, but a macroscopic, rotating charge, sitting on a magnetic dipole, immersed in a homogeneous magnetic field. An electron is always the same irrespective of its environment. The magnetic monopole as a quasi-particle is engineered by the Curie method, induced symmetry reduction. It cannot exist without an external magnetic field, while an electron exists without external fields. The charge of an electron (hopefully) cannot be changed. The charge of a magnetic monopole is not conserved; it is a topological charge. Without an external magnetic field, it will be reduced to a rotating charge, generating only a spin field.

This experiment is more relevant to nature, and in biology as well. it never caught the attention of the mainstream, except for V.A. Mikhailov.[6]

This quasi-particle is of no technical importance, but condensed plasmoids as nearly stable toroidal vortexes do have technical importance.

While colloids (solid particles in liquid) are useless to create magnetic monopoles, there is another solution in biology to have a three axis rotation of charges. Triple-wound long, organic molecules may conduct electrons and ions in such a manner. Acupuncture meridians do exhibit physical features of a magnetic current, as their impedance (capacitance and inductivity) is markedly different from the neighboring skin tissue. This is the technical means by which western doctors locate them, and thus their reality is easy to verify.

Now we shall get to the spin field, which is created by a single axis charge rotation. The more complicated magnetic charge was discussed earlier because it is more familiar to the reader.

Spin Field, Spin Charge, Spin Current

Spin as a quantum mechanical concept is known to the readers. Now we shall discuss it as a macroscopic field, created by rotating charges.

Based on the above, the source of a static spin field is a current loop current, div $S = I \times \omega$, that is, the net current of the loops multiplied by the charge angular velocity ω.

Note: electrons must be a source of the *S* field as well, as they have spin and rotate by themselves. But on a conductor, their spins are not aligned, only in the presence of an external magnetic field.

There are no stand-alone spin only charges; the electron is a source of electric charges, and the source of magnetic and spin fields as well.

We have previously discussed that both static and dynamic rotating electric and magnetic fields can be produced by our current technology. (But in life, the complicated protein Complex V in mitocondria, and the rotating ATPase enzyme, are able to maintain static spin fields.) A spin field is much stronger than the electric or magnetic fields around living beings.

Note that rotation of a charge is qualitatively different from that of a static, or linear, path charge. Static or linear movement yield quite different fields (electric and magnetic) so the rotation of charges is expected to yield again a

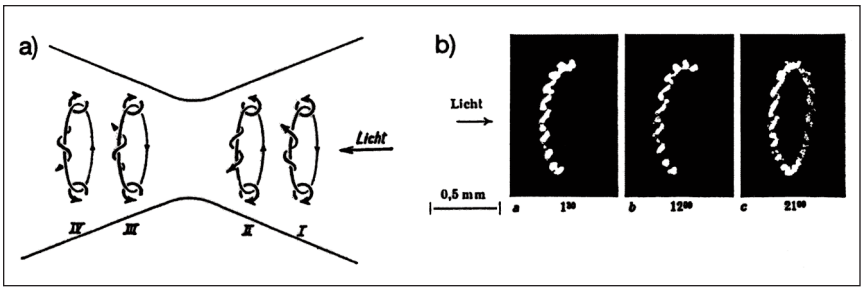

Figure 6. Spin field in Ehrenhaft's experiment. Light rotates a dust particle around a toroid surface due to the effect of spin field.

qualitatively different field from both of them! As discussed before with simple, high-speed rotation of charges on a disk, no spectacular effects are expected, though some inventors (Testatica, Hyde, Godin, Roschin) did find it useful.

A spin field had to appear in Rowland's experiment of 1876 as a macroscopic orbital spin, but it was not noticed. The technical challenge is enormous. Even the magnetic field of the rotating electrically charged disk was so weak that it was weaker than the geomagnetic field by five orders of magnitude (*Berkeley Physics Course*, Vol. 2, 1965, McGraw-Hill, p. 216). The emerging magnetic field was detected by magnetic needles, aligned with the emerging magnetic field, but this setup is not suitable to measure a spin field. This is because a spin field generates torque, and not attractive (or repulsive forces, electric or magnetic fields).

As shown in Figure 2, a spin field is characterized by both a polar vector and an axial vector yielding vortex ring-like structure. This is already a surface and not a force "line." This object is a tensor of second rank.

It is very hard to make a drawing of it, as it requires imagination. The stress tensor is similar in mechanics, when torque and stress are applied simultaneously. In fact, spin fields are generated at the end of permanent magnet rods, but they are so weak that their torque is dwarfed by attraction or repulsion.

When such a rotating charge moves along a line, a "spin current" is generated. The spin current will generate yet another type of field, named a "torsion field" by a Russian scientist, and this new field is also a member of the electromagnetic field family. It will rotate charged objects along two axes, perpendicular to each other. Note that spin current may generate torsion fields in three different manners. (The torsion field itself is already a rank three tensor, like a strain tensor.) The first spin current type is generated when the angular and translation velocities are parallel. The next type of spin current is when they are perpendicular to each other. The third current is generated when the rotating charge rotates by another axis.

This is not a figment of the imagination but an unexpected test result in Ehrenhaft's research. The first results were published by Felix Ehrenhaft in the 1930s, but the fields were not generated by mechanical rotation, but by induction—light, as a source of spin and tension field.

As with Hertz, there was no easy way to prove Maxwell's displacement current, that is the magnetic vortex field created by changing electric field. Hertz had to go to the Gigahertz range to verify it.

Ehrenhaft used polarized visible light, an even higher frequency, to find the vortex shaped force field! His first paper was published in 1930 in *Physics Zeitschrift*, then a leading journal.[14] The path is definitely a toroidal one, as shown in Figure 6.

F. Mikhailov published a full reference to Ehrenhaft's work[6] and many papers described this toroidal vortex field. But now, these results are as forgotten as are the Norman Collie *et al*. results on transmutation of hydrogen into helium (in 1914).[4]

Figure 3 shows a simple sum of a straight and a loop current has a strange magnetic field; it is no longer closed! If we are to understand the conditions to form condensed plasmoids, and thus LENR (including biological transmutation), then we must remember the induction of spin and torsion fields by Ehrenhaft, not only the transverse waves of Hertz.

Needless to say, it will not fit the Maxwellian frame, because rotation of charges (currents) is not considered today as an effect in physical reality. Rotation of charges around two axes, or the combination of translation (reflection), takes us to a quite different footing—non-commutable operations, that is non-Abelian physics. It always produces counterintuitive unusual effects that are never expected.

Generation of Spin Field

After clearing the source and current (Biot-Savart law) terms with a rotating charge, the extension cover's Faraday induction terms, as well as a new term $\partial S(t)/\partial t$. The torsion field is neglected now, but it is in the next similar term.

The third dynamic, induction equation has the same vortex form, where the density of spin $\rho_s = \rho_e \cdot \omega \cdot v$ and spin current is simply the current of rotating charges.

Thus the third induction equation has the same vortex form: rot $S(t) = \rho_e \cdot \omega \cdot v + \partial E(t)/\partial t + \partial B(t)/\partial t + \ldots$

Note: in a copper wire, electrons move in a random manner. Only a strong permanent magnet wire, or a chiral media, may generate a spin current, but the latter is organic material.

Now we have a crude model to grasp the possible EVO, or condensed plasmoid formations.

Tentative Model of Condensed Plasmoid Formation

LENR is a multi-step process; the formation of CP and surface plasmons as catalysts are unexpected, unusual, but similar to biological processes. The catalytic phenomena for both processes will be discussed in Part 2.

We shall now outline only the tentative CP formation. It is similar to the formation of Helmholtz toroidal vortexes. The following conditions are to be met:

1. The plasma vortex must be formed during a short discharge phenomenon. The rise time is not arbitrary. Along the azimuthal axis (shorter radius) one, two, etc. rotations must take place to have fully finished rotations, thus a closed ring. This criterion is a must for the first full rotation and, if not met, a condensed plasmoid will not be generated. It is no wonder that transient discharges are found in most catalytic fusion LENR inventions, in one way or another.

2. The initial plasma filament must have a circular symmetry. A needle (Shoulders) or a sharp-edged crater (Correa) is important in their formation.

3. Partial (not full) ionization is enough.

4. The spin field, with double vortexes around the small and large radii of the charge torus, will "wrap up" the plasma (see Figure 7a and b). Ordinary *E*, *B* fields will not rotate the plasma! Here the necessity of the spin field appears. The spin field is generated by the sudden change of the *E* electric field, when the arc discharge is formed. The toroidal charge cluster may be formed due to the presence of freely moving charged particles in the plasma, at the cathode.

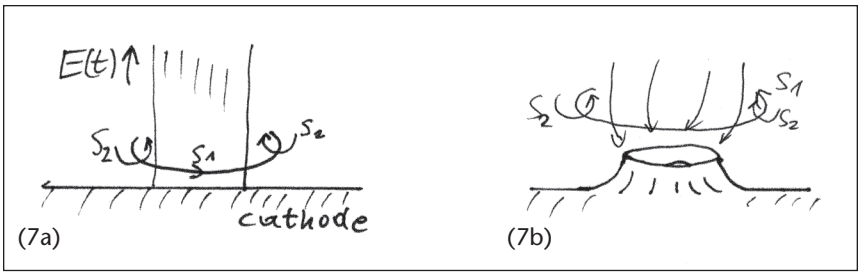

Figure 7. (a) Transient arc discharge above a cathode. Spin field is induced by a transient. (b) The sharp edge of a crater on a cathode yields an enhanced transient electric field, thus the spin field generation is more pronounced.

5. The plasma must contain hydrogen isotopes, to help fusion, so water vapor or carbohydrates are also suitable for the plasma material. It is an open question whether condensed plasmoid can be formed, let's say in mercury, sodium and other heavier gases. Though gas discharges come in a wide variety, controlled (catalyzed) fusion by CP takes places only if the above criteria are met.

Neither the discharge, nor the plasma oscillations alone, cause the excess energy (as Tesla, Moray, Chernetzky, Correa, or Andrei Sakharov etc. assumed), but a catalytic fusion process by CP does.

The carbon button lamp of Nikola Tesla satisfied all the above criteria, as well as Collie's high voltage discharges in hydrogen early in the 20th century.

The Curie principles of induced symmetry breaking, or symmetry reduction, is met in the above manner during the condensed plasmoid formation period.

The dynamical terms, or vortex terms, will now include spin fields as well.

Electrical currents create a magnetic vortex around the conductor. Its symmetrical counterpart is when a magnetic current creates an electric vortex. Thus, rot $E(t) = \rho_m v + \partial B(t)/\partial t + \partial S(t)/\partial t + ...$

The first term reads: an electric vortex is created when magnetic currents have a linear velocity, first term on the right hand side. The second term reads: an electric field vortex is created by a changing magnetic field (Faraday's induction law, very useful industrially). The last term reads: a vortex electric field is created by a changing spin field.

Here we have to face a new feature: the symmetry of a spin field is lower than that of a magnetic field, and only a toroidal field will satisfy it. Their interrelation is shown in Figure 2. (The next similar explanation will describe the creation of a magnetic vortex field. As a formal extension, a dynamic spin field term is added.)

A changing magnetic field generates a vortex electric field but at the same time a spin field is also generated around the electric vortex field lines. However, this field has a lesser symmetry—a toroidal field—which has (at the same time) two rotation spin field components, perpendicular to each other. One is around the magnetic field and the other is around the electric vortex field. Thus the spin field has a doughnut or toroidal shape.

This is not a vector field, but a tensor field of second rank, in fact. It has less symmetry than either an electric or a magnetic field but it has novel properties. A free charge will have a toroidal movement placed into either a changing electric or a magnetic field! Indeed, we have evidence about that from Ken Shoulder's EVO tests, to be discussed later, and saw some of the forgotten results of Felix Ehrenhaft of Vienna in 1930s.

The "mirror symmetrical" counterpart of the extended Faraday law is the Oersted-Ampere term, and the Maxwell-Hertz dynamic term rot $B(t) = \rho_e \cdot v + \partial E(t)/\partial B(t) + \partial S(t)/\partial t + ...$ That is, a magnetic vortex field is created around an electric current, around a changing electric field (predicted by Maxwell, proven by Hertz) and a changing spin field. The spin field is toroidal again; it rotates around the changing electric field, and around the magnetic vortex, just like the electric field in Figure 2.

Faces of LENR

Low energy nuclear reactions are pervasive in nature. Both fusion and fission take place, but this paper, as readers already realized, concentrates on fusion only. Even in the most quoted process, the electrochemical Pons-Fleischmann cell, both fusion and fission may take place at the same time. Fusion of light hydrogen isotopes, and fission of Pd isotopes due to the THz oscillations of cracks, are due to the diffusion of hydrogen into the crystal lattice (test results of Carpentieri *et al.*). Fission may take place in geophysical phenomena as well, due to ever present tremors, but at an exceedingly slow place, as is the terraforming process of biological transmutations. Skeletons and shells have built mountains, over millennia, and removed deuterium from primordial oceans. That produced oxygen from carbon and made it possible for life to develop into multicellular organisms, for whom deuterium is deadly.

Fission does not require a catalyst, just a solid, crystal lattice, where high-frequency oscillations happen; it can't take place in plasma or a liquid.

Fusion, the technically most valuable process, requires a catalyst. In the opinion of this author, there are five types of possible catalysts for LENR fusion.

1) Neutrinos, as proton+energetic electron (wave), require a neutrino to preserve parity. There is a neutrino flux through the universe, but at a modest flux, which is a "bottleneck." Alexander Parkhamov suggested[16] that at elevated temperatures (above 1,000ºC), enough low energy neutrinos are generated with high enough reaction cross section to initiate fusion between light nuclei and electrons.

2) Formation of condensed plasmoids, as high mass, charged quasi-particles, by transient discharge, in plasma containing hydrogen isotopes. Fortunately these weird objects leave a

trace on metals (visible in polarized light, under a microscope), or with carefully primed high speed video cameras.
3) Surface plasmon polaritons, that is, high virtual mass, high electric density plasma waves above conducting surfaces. These quasi-particles will not be fashionable to research, as they do not leave any visible mark and therefore there is only circumstantional evidence for them.
4) Polyneutrons were found by John Fisher[17] as unusual neutron clusters. They can be found as "naked" neutrons only in clusters, or "pot belly" nuclei, with relatively stable neutron-rich isotopes.

These neutron-rich heavy isotopes are hard to detect. Mass spectrometers are suitable in principle, but not in practice. The detectors of the separating quadrupoles are monitored by software, provided by the supplier. And the software is not prepared to accept or detect these monsters. The ICPM software fight hard to separate neighboring elements with the same or similar mass, as they may have quite similar paths, indistinguishable for the sensitivity of a given detector.

X-ray-based devices (electron dispersive X-rays) interact with the inner electron paths; the number of neutrons do not influence the outcome. Maybe occasional decays, electron or alpha emissions leave a trace, but they are immediately absorbed by their environment, and never reach detectors beyond a reactor wall, glass or metal.
5) Deep orbit electrons. These local charged bosons (theory developed by Muelenberg, Sinha) are also rather foggy, and do not help us to design proper devices, but they can't be ruled out as a side effect.

Obviously a combination of the above effects may take place; heavy neutron isotopes of John Fisher sometimes yielded the same result as condensed plasmoids.

So far, the picture is foggy, and much more work is needed, but the readers are familiar with the brutal censorship in this area, so there is little hope to clear the picture soon.

Why Are Condensed Plasmoids So Rare?

The physics of weakly ionized plasma is a vast field at the borders of applied electrodynamics, quantum mechanics, surface and material physics, with dozens of subfields. (The physics of fully ionized high energy plasma, steady and transient, is an even bigger area; this is hot fusion.)

This author has spent most of his life becoming familiar with both the technology and theory of a narrow area: transient weakly ionized plasma. In this area, I dealt with only microwave (contactless) and electrode-driven pulsed plasma, which are two distant, tiny islands of possible plasma formations.

After reading very long textbooks, pouring over hundreds of papers, there was not even half a sentence is devoted to an experimental observation of condensed plasmoids. There must be objective and subjective reasons.

The objective reason is the failure to find condensed plasmoids. Gas discharge or plasma has been studied for over a century. It was at the forefront of physics for half a century. The discovery of spectral lines, electrons and nuclei, etc. are due to this study. Transient, intermittent gas discharges in the form of a corona (inventions and observations of Shoulders, Collie, Tesla) were intensively and exhaustively studied by many researchers. The most general textbook is written by L.B. Loeb (*Electrical Coronas*, with 700 odd pages); surfaces were considered there for sputtering only for various electrode materials, pressures and gases. There were no high-speed video cameras, and cathode surfaces were not examined under a microscope in polarized light, as noted by Bob Greenyer.

Surface impacts were studied only for heavy particles, but not in hydrogen (E.W. McDaniel, *Collision Phenomena in Ionized Gases*, Wiley, 1964). Again sputtering was studied, and not pattern formations on electrodes in transients.

Calorimetry, or chemical analysis of cathode surfaces, was never performed, as nothing new was expected.

Relatively new, comprehensive textbooks tend to give a unified view of several gas discharge types, and leave no room for new phenomena (such as Y.P. Raiser, *Gas Dischage Physics*, Springer, 1991).

The list of other books on plasmas is exceedingly long, and I won't mention any others.

By now, the heyday of experimental gas discharge study has been over for two generations. By this time, diagnostics, especially X-ray based and mass spectroscopy, is relatively inexpensive and accurate. The field of weakly ionized transient plasma is bone dry; even the area of industrial applications is shrinking at an accelerating level. This is the usual viscious circle: no new useful results, no funding, no glory. Nothing is expected.

A subjective reason is bias. This author is a good example of unintentional biased data (info) filtering, blocking. Though I met Dr. Matsumoto in person, in Sapporo, Japan, at ICCF6, I was unable to comprehend what he demonstrated. He talked about "miniature ball lightning," which is not correct, as ball lightning has different features in reality.

When investigating the cathodes of Correa and Chernetzky, only the sub millimeter craters were noted with a circular molten pattern, but it is not the micron-sized CP trace.

It was only when I saw the traces of condensed plasmoids on the Ohmasa metal mixing plates that the evidence became irrefutable for me. So the journey to accept the unacceptable may take decades, at best.

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