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Quantum interpretation of LENR neutron generation in pinch experiments

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Abstract: In this paper, I will present and interpret LENR phenomena that are appearing during pinch experiments, where high voltage electric pulses are applied on conducting linear structures like metallic wires, conducting liquids, or gases. The LENR appearance in neutron generation in strong pinch experiments with Deuterium gas inside cylindrical tubes is also presented.
Keywords: LENR, neutron generation, plasma, Stark effect, z-pinch

I. Introduction

The Pinch effect has been initially studied by BENNETT as soon as 1934 [1] and is considered as the core theory for interpreting implosion effects https://en.wikipedia.org/wiki/Pinch_(plasma_physics)

According to the pinch theory, a strong electric pulse applied on a conducting linear structure generates a strong current accompanied by an analogously strong magnetic field which then suppresses the conducting structure resulting in the implosion of the material structure. The pressure developed then can lead to neutron production due to the affected strong ionic collisions. It was hoped that if the pinch effect gets sufficiently strong even fusion phenomena could appear due to sufficiently high pressures and temperatures.

Most known efforts were concentrated around experiments with linear cylindrical bottles filled with Deuterium and Hydrogen, where it was hoped that the enforced collisions would overcome the Coulomb barrier resulting in standard Deuterium Fusion nuclear reactions D-D, generating more fusion energy than the input electric pulse energy. An excellent old paper from 1957 by Laurence Berkley National Laboratory [2] describes in detail an experimental effort related to pinch based neutron generation.

As an extension of pinch implosion theory in linear-shaped plasmas, a torus shape plasma structure (TOKAMAK) was also proposed in which, instead of the pinch-generated magnetic field, the plasma would be suppressed by an independent strong external magnetic field which was assumed to increase the probability of fusion reactions in the plasma medium.

The expectations of achieving extensive fusion reactions, generating more thermal energy in relation to the electricity consumed in the relative structures, have not yet been achieved either in linear or torus plasmas. As was noticed by many scientists the neutron generation in the pinch experiments is not as predicted by the pinch implosion theory [3].

The author's current understanding is that the poor results are not only related to inefficient use of the technology according to the existing pinch implosion theory but also to a poor theoretical interpretation of the phenomena that appear by the existing theoretical model of the pinch implosion itself. In the next paragraphs, an effort is made in presenting a new viewpoint concerning a different physical interpretation for this discrepancy and bring to light the hidden LENR phenomena that precede any pinch based fusion phenomena.

According to this, the acclaimed Low Energy Nuclear Reactions (LENRs) are not fission or fusion nuclear reactions. LENR is generated when a free electron under special conditions overcomes the Coulomb barrier of an atom, enters its nucleus, and transforms a proton into a neutron. From this point of view, the electron capture phenomenon is the basis for a correct theoretical understanding of LENR effects.

In paper [4] a possible explanation of LENRs in the area of so-called "Cold Fusion" experiments was presented. Although the explanation was deemed erroneous [5] the argument that LENRs are caused by electron capture forcing nuclear reactions leading to transmutations can still be valid for different reasons.

The main argument presented pertains to preceding LENR generation in pinch experiments. The preceded LENR phenomena create their own nuclear reactions and generate their own neutrons. It is possible that the neutrons generated by LENR reactions could interfere with the implosion based fusion events.

Hence, there is reason to believe that part of instabilities in pinch experiments originate in some intermediate, transient LENR reaction, some of which may have explosive characteristics hampering partially the pinch based implosion process and the expected concentration of plasma necessary for intense fusion phenomena. Hence possible LENR effects related to pinch experiments should be studied more carefully.

Also, any LENR phenomena related to low energy pinches, applied in special linear conducting structures, could generate LENR nuclear energy higher than the electric energy of the input pinch pulses, that is possible to be achieved.

II. Eigenfunctions of linear conducting structures

The conducting structures we are interested in approximately can be considered as one-dimensional thin (linear) or two-dimensional thin (planar), distributed systems containing free electrons (or a free electron gas).

The electron gas is spread in the mass of the conducting structure; however, we can consider approximately that their electrons are mainly on the surface of the thin conducting structures since there will also be a strong skin effect at the transient period which is mainly of interest in the present analysis.

Any external instantaneous voltage electromagnetic field will mobilize the free electrons, but when this excitation disappears, the electrons will stop moving due to scattering with the positive lattice ions, which appear macroscopically as electric resistance. Thus, any conducting structure can be considered as a bottle of free electrons enclosed by the boundaries of the structure and obeying the Schrodinger equation.

In pinch based experiments the conducting structure is linear and we are going to focus on this special case of a straight linear conducting structure of negligible thickness and length L. The free electrons inside a linear conducting structure will move, near its surface, under any external voltage excitation V and the system will behave as a quantum resonator defined by the spatial Schrodinger equation.

$\partial^2 Y(x)/\partial^2 x = -(\varepsilon - U) \cdot Y(x)$, Where: $(\varepsilon - U) = \frac{2m}{(h/2\pi)^2} * (E - V)$

The wave eigenfunctions of the free electrons inside the conducting structure can be defined by the respective wave Schrodinger equation considering V=0.

In the classic Bohr interpretation of the Schrodinger equation, the function $|Y(x)^2|$ defines the probability of an electron to be in point x. Due to the extremely high number of free electrons, we can assume that $|Y(x)^2|$ is proportional to the number of electrons at x, thus this function defines the electric charge along the conducting linear structure.

Due to the wave nature of the Schrodinger equation, the functions $Y(x)$ without any external voltage excitation should be a set of eigenstates $Yn(x)$ with respective eigenvalues εn defined by the geometric boundaries of the structure where the wave function is considered zero.

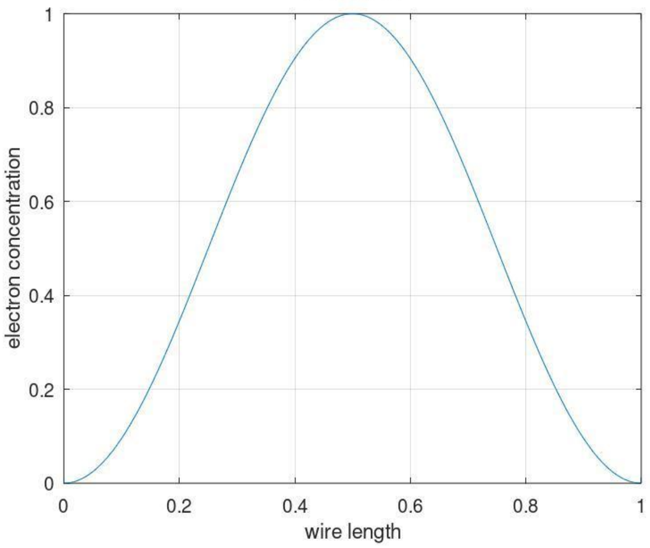
The general problem of eigenvalues and eigenfunctions $Yn(x)$ calculationfor an arbitrary conducting structure is complicated and can be tackled only numerically, however, the eigenvalues and the eigenfunctions in the case of a straight linear one-dimensional conducting structure have a known analytic expression.

Specifically, for a thin linear conducting structure of length L, obeying the Schrodinger equation, where $|Y(x)^2|$ is the electron concentration function along the linear structure, due to the boundary conditions Y(0)=0, Y(L)=0, can be defined as

$$Yn(x) = A * sin\left(n\pi \frac{x}{L}\right), \qquad \varepsilon = (n\pi/L)^\wedge 2$$

Thus, the fundamental $Y1(x)$, which has the minimum energy $\varepsilon 1 = (\pi/L)^\wedge 2$, is given by $Y1(x)$=A*sin(π*x/L) and for this fundamental harmonic the electron concentration will be given by $|Y(x)^2|$ =A^2*[1-cos(2π*x/L)]/2 shown for A=1 in figure 1

FIGURE 1



Thus, for the fundamental harmonic the electrons tend to concentrate near the middle of the linear conducting structure. With thousands of experiments, we confirmed the mentioned electron concentration in the middle of thin wires under non-destructive electric pulses, that in several cases can create wire disruption in the middle due to electron repulsion [6].

Let also be noticed that the respective time-dependent Schrodinger wave functions of any conducting structure are standing waves of a frequency ω defined by the speed of electromagnetic waves in the structure and its dimensions of the form $Yn(x,t)=Yn(x)$*Real{exp(jnωt+φ)}. The spatial wave function, due to its temporal component, is pulsing with frequency n*ω and thus the electron concentration function in the middle of a linear conducting structure will be pulsing with frequency 2*n*ω.

III. LENR generation in pinch experiments

If we look carefully at the pinch effect caused by a sudden discharge and current surge in any conducting linear structure we can distinguish two different phenomena, a transient one created by the initial rising part of the discharge pulse that affects the free electrons in the linear structure though the Schrodinger wave equation and the rest of the classical pinch phenomena related to electromagnetism through the implosion equations [1].

For any external pinch voltage excitation applied on a conducting structure, there is an extremely short period where the voltage on the structure is increasing suddenly, which is equivalent to an application of a δ function type voltage. In this short period, the linear conducting structure is accepting a series of voltage harmonics generated by this sudden peak voltage, several of which have the same frequency as the eigen-harmonics of the conducting structure. The strongest effect is expected to arise by the one exciting the fundamental harmonic of the conducting structure.

Thus, according to the previous paragraph theory, during and after the short period of the δ function type voltage, a number of repeating instantaneous concentrations of electrons in the middle of the linear structure will take place. This instantaneous overpopulation of electrons is expected to have a secondary effect on the appearance of a new strong voltage potential function in the middle of the linear conducting structure.

This strong internally generated voltage potential in practice can also affect the various lattice ion atoms and this influence can be approximated as a pulsating wall of the charge against a lattice ion atom. In such a case a local ion atom will see a very strong electric field which will cause a transient Stark effect, leading even to a Rydberg state raising the possibility of naked lattice nuclei due to a retraction of the internal shell orbitals by this powerful local Stark effect.

This hypothesis regards the possibility in the case of high-power excitations on linear conductors to be able to severely lower the Coulomb barrier of their lattice ions near the middle of the conductor and cause LENR transmutations at least with some probability directly dependent on the increased cross-section of bare nucleic matter.

As is already proposed, LENR effects are due to the entrance of nearby free electrons into the lattice nuclei trans-mutating protons into neutrons. In this case, due to severe Coulomb barrier lowering, the necessary electron energy in order to transmute a proton to a neutron is given by the electrostatic energy of the proton-electron couple.

IV. Preceding LENR phenomena on plasma pinch experiments

As early as the 1950s [3] it became apparent that we can create neutrons if we apply a strong electrical pulse into a cylindrical vessel containing a mixture of hydrogen and deuterium gas. The process by which this was achieved has been described in many published articles from which it is evident that when a bank of capacitors is charged by some electrical source accumulating electric energy being then discharged in a deuterium plasma, results in the creation of a considerable number of neutrons some of which are believed to have been created by nuclear fusion reactions. However successive experiments and devices built up to date have not managed to create more nuclear energy than the electrical energy of charging the capacitors.

In many articles as in reference paper [3] it is stated that the number of neutrons produced in pinch experiments is incompatible with the existing pinch-based implosion theory. In the author’s view, the existing pinch-based theory following the original Bennet’s [1] implosion theory refers to stationary electromagnetic phenomena while the discharge of any capacitor bank necessarily contains a transient initial stage which is not included in any theoretical analysis.

Assuming that neutrons created by any LENR effects, influence the overall plasma discharge, which seems quite possible, we can also predict that by a direct control of any LENR based neutron production in a deuterium hydrogen plasma we could possibly enhance the implosion creation of fusion reactions and therefore to strengthen the respective devices that intend to generate more nuclear energy than the electric discharge energy of their capacitor bank.

It appears plausible to consider that the Deuterium plasma in cylindrical vessels, despite a considerable diameter, is approximately similar to a set of parallel linear conducting structures, which are then forced to approach each other due to pinch implosion effect as in Bennett's theory [1]. However, before full implosion takes place, all these parallel straight linear conducting structures will accept the initial voltage potential of the discharging pulse by the capacitors and according to the previous analysis, a pulsating set of electrons moving from both ends to the middle of the plasma would appear.

The voltage potential generated by the concentration of electrons in the middle can affect the deuterium atoms near the area weakening their Coulomb barrier, reacting statistically with the nearby free electrons, and creating their own neutrons through LENR effects in which protons of deuterium atoms are transformed to neutrons.

An important conclusion drawn from this study, pertaining to the effects of strong electric pulses in

conducting Deuterium plasma structures, is that the Bennett's implosion theory [1] alone is inadequate and should be combined with the initial quantum origin of the concentration of electrons in the centers of the plasma linear conducting structures. The free-electron accumulation in the middle is probably responsible for the creation of initial nuclear reactions, due to the transformation of nuclear protons to neutrons and secondarily in several cases strong nuclear transmutation phenomena (fusion) are appearing due to the so-called Pinch based implosion effect.

Controlling LENR phenomena in linear conducting plasma devices used for fusion generation may then allow realistically increasing their yield, i.e. increasing their output fusion energy generation for a given electric energy input.

V. Curvilinear conducting structures

Quantum phenomena in conducting structures are related to the geometry of the structures. The general problem of calculating eigenvalues and eigenfunctions arising from Schrodinger dynamics in non-planar (non-Euclidean) two-dimensional structures is very complicated and can be tackled only numerically.

However, the one-dimensional non-Euclidean case, i.e. the case of curvilinear conducting structures can be tackled numerically more easily and in special cases, the wave characteristics of their trapped free electrons have analytic forms.

The Schrödinger wave equation for a one-dimensional (thin) curvilinear conducting structure developed along its parametric length *s* with can be proved [7] that can be written as follows

$$\partial^2 Y(s)/\partial^2 s = -\left(\frac{\sigma^2(s)}{4} + \varepsilon\right) \cdot Y(s)$$

The standard curvature can be given by the local radius *R(s)* via the relation *σ(s)= 1/R(s).* The curved linear conducting structures of constant curvature σ are in general three-dimensional helices given by the set of equations in Cartesian coordinates as follows

$$x(t) = a * cos\, cos\, (t)\,, y(t) = a(t)\,, z(t) = b * t, 0 \le t \le T$$
$$and\ s(t) = t * sqrt(a^2 + b^2), thus\ L = T * sqrt(a^2 + b^2)$$

The constant curvature σ of this helical wire is given by

$$\sigma = |a|/(a^2 + b^2)$$

As a result, for the boundary conditions *Y(0)=0, Y(L)=0,* the first harmonic of Y(s) will be given by

$$Y(s) = A * sin\left(\pi * \frac{s}{L}\right), \qquad where\ \ \frac{a^2}{4(a^2+b^2)\hat{}2} + \varepsilon\ = \left(\frac{\pi}{L}\right)^2$$

Thus, the minimum energy for excitation of the first harmonic it will be given by the relation:

$$\varepsilon\ = \left(\frac{\pi}{L}\right)^2 - \frac{a^2}{4(a^2+b^2)^2} > 0$$

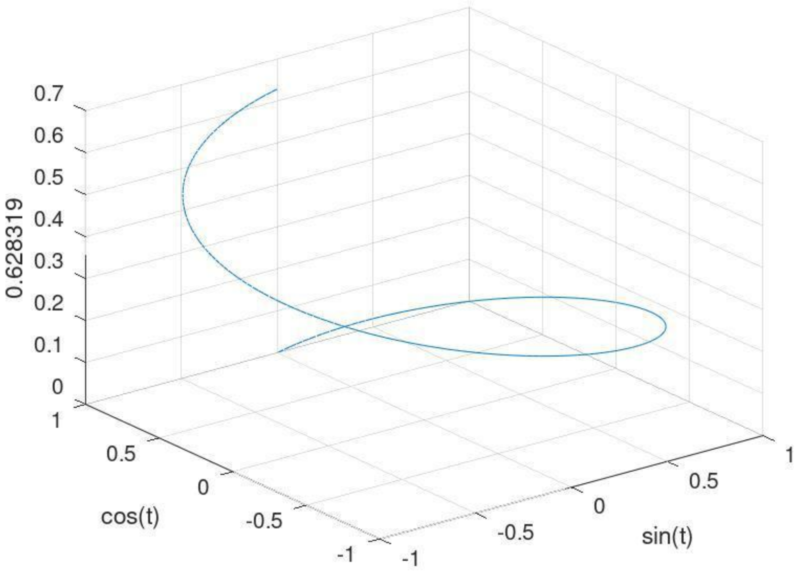
Let us assume for example that T=2π, hence $L = 2\pi * sqrt(a^2 + b^2)$

$$\varepsilon\ = 1/4(a^2+b^2) - \frac{a^2}{4(a^2+b^2)^2} > 0$$
$$\varepsilon\ = \left[\frac{1}{4(a^2+b^2)}\right] * \left[\frac{b^2}{(a^2+b^2)}\right]$$

Thus, by simply taking b << a, the minimum energy of the fundamental eigenfunction can become negligible and the curved helical wire can be excited by a negligible voltage potential. For T near the 2π, the minimum energy can become negligible for the appropriate relation of the constants a and b. In the author's opinion, this may also be one of the reasons for the self-explosion of "*zombie*" (expired) lithium batteries due to accidental formation of helically shaped micro threads or "*dendrites*" of pure Lithium inside them.

A helical curved wire of a=1, b=0.1, and length approximately 2π is shown in figure 2

FIGURE 2 HELIX



VI. Conclusion

In the article, a theory was presented regarding the possible appearance of LENR phenomena during the application of very rapid high-voltage electrical pulses (pinches) to linear conductors or cylindrical bottles filled with Deuterium. The LENR phenomena are created when free electrons manage or are forced to penetrate the Coulomb barrier and enter the nucleus of atoms. This phenomenon is called electron capture and occurs naturally in several cases [8].

In the spontaneous electron capture phenomena, free electrons enter the nucleus of atoms, join with nucleus protons, and turn them into neutrons. The forced electron capture leads to a Low Energy Nuclear Reaction (LENR) where transmutation of the atom involved is taking place, accompanied by the production of neutrons. The generated neutrons in particular devices, usually plasma in special bottles, operating with strong electric pulses or pinches, can be used in order to finally cause Fusion nuclear reactions planned to generate more energy than the energy of the ignition electric energy.

It is also possible that understanding and enhancing the creation of LENRs into Fusion plasma devices could greatly increase the Fusion energy created and achieve the ultimate goal of replacing fossil fuels with nuclear energy of unlimited resources. Low Energy Nuclear Reactions (LENR) can be used also as another option for nuclear energy generation without radioactivity and also with unlimited resources.

Low Energy Nuclear Reactions (LENR) can be used also as another option for nuclear energy generationwithout radioactivity and also with unlimited resources.Our company PAP-LENR Inc is planning to build a prototype LENR thermal machine that will produce manytimes more energy than the electric energy of the pinch pulses generating the LENRs in the relative machine.

An initial poster of our LENR research activities was presented during ICCF-24 conference, where we were invited.

VII. Acknowledgements

I would like to mention the fruitful remarks during the writing of this paper from my close friend and collaborator Theophanes E. Raptis.

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