

Ionic Metal Power

Low Energy Lattice Assisted Nuclear Transmutations



The LELANT Hypothesis : Theory & Experiments

Low Energy Lattice Assisted Nuclear Transmutations

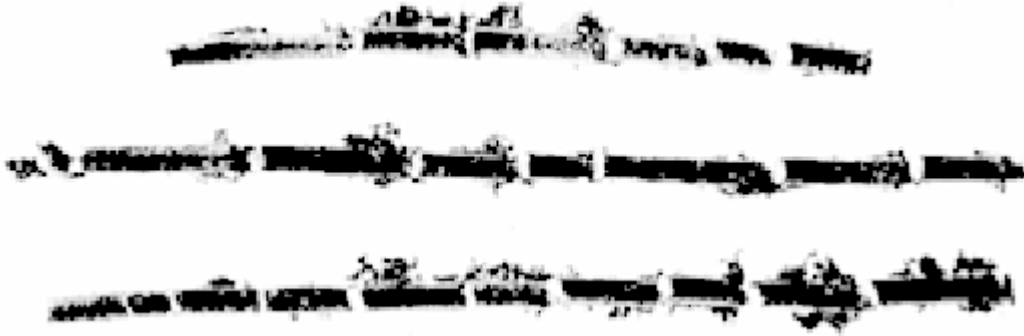
(Filed Patent Application No 20100100446, Greek Industrial Property Organization)

- The history of “*Wire Fragmentation Phenomena*”
- The relation with the acclaimed LENR effects.
- Our theory
- Experimental evidence
- Simulations

History

1. The beginning of it all

During the 60's Nasilowski, an electrical



cal engineer was examining the subject of collapse of electrical fuses during short-circuits when he observed that at certain values of the instantaneous current flowing through the conductors material, the whole wire was exploding instead of melting.

Nasilowski, was using a simple circuit with a capacitor bank and a load resistor to excite the wires into this peculiar behavior. Microscopic examination of the resulting fragments showed that the wires had been broken into small pieces across their lengths as if there was a longitudinal force inside the metal.

This was a major problem for the simple reason that there is nowhere such a force predicted in the framework of Maxwell theory of Electrodynamics. Either there was a need for the radical re-examination of Maxwell theory (with huge consequences for all other fields!) or something very peculiar was taking place inside the material akin to the metallic structure.

Nasilowski was so impressed that wrote a book with all his observation in 1964 titled "Electrodynamic wire explosion" [1]. In certain discussions that followed it occurred that others may have seen similar phenomena before and ignored them. In fact, during the 19th century, when Electromagnetic theory was still in its infancy, there was a controversy concerning the correct way to write the mathematical expression of the law of force between two current-carrying linear conductors ("wires").

This force is not directly exerted between the currents flowing but is the intermediate result of the mediation of the magnetic field produced by each one which then affects the other. The combined result is nowadays expressed through the differential law of Biot-Savart (force/infinitesimal length). During the middle of the 19th century though there were two compelling expressions given by Ampere and Grassman respectively. The first one was so written that would allow under certain circumstances to a flowing current to suffer longitudinal forces. However no such case is ever found in practical applications and as a consequence Ampere's law was finally abandoned. At least, until Nasilowski's experiments showed up!

2. The "Galilean" turn

During the 80's, an attempt to revive Ampere's law has been made by several authors, the most important being Graneau, Papas and Aspden [2, 3, 4, 5]. Later on, Rambaut and Vigier published similar papers in an attempt to find a compromise between Ampere-Lorentz and Grassman forces based on a relativistic analysis. The last two made experiments in heavy water containing Deuterium isotope and Lithium salts that proved the release of neutrons and thus the possibility of nuclear transmutations. In fact they went so far as to claim the possibility of fusion! A relevant patent for "*capillary fusion*" was filed and awarded in 1991.

The whole issue of the Ampere – Grassman controversy turned out to be related with a far more general attempt for a return to a form of "*Galilean Electrodynamics*" which implies a negation of the well known "*Lorentz transformations*" that have been proven to leave invariant Maxwell's equations and their replacement with the so called "*Galilean transformations*" that are akin to the pre-relativistic *Classical (Newtonian) Mechanics*. This attempt culminated with the advent of the Galilean Electrodynamics [14] magazine. A mostly used version for the reformulation of modern electrodynamics is often given in the form of Weber's electrodynamics of which the main characteristic is the use of total time differentials in similar equations (including a "*convection*" term) instead of the partial derivatives used by Maxwell.

This is a far reaching concept with far reaching ideological -and even political!- implications as its main root lies in a hidden animosity against Einstein's work and relativistic theories in general. And of course it is strictly impossible to doubt Einstein without doubting Maxwell as the two corpuses are intimately and inherently connected.

This whole discussion of course, casts its shadow on other more important issues that should be studied with more modern methods like quantum theory of metallic lattices instead of getting us back into the discussions of the 19th century. The neutronic emissions reveal that true nuclear phenomena may take place inside such metallic substances that have to be understood. Abandonment of Maxwell theory would not help as it is already established by thousands of everyday applications. It would be at least weird, if Weber or any other type of electrodynamics decided to manifest itself solely in the case of exploding wires or even some other side effects.

3. Modern viewpoints

A regeneration of interest in exploding wires came from plasma physics where some devices with similar properties were used for decades. Better known as the Z-pinch and X-pinch devices, they were first introduced as a means to find experimental data necessary in the efficient design of thermonuclear weapons. Later, there was a hope that with sufficiently high currents the plasma produced by the explosion could reach pressures and temperatures necessary for a controlled fusion reactor.

M. Taylor [9] performed certain experiments and observed the plasma formation around exploding copper wires and tried to explain the type of current flow including the plasma conductivity.

Friedwardt Winterberg [10] was the first to propose an unorthodox interpretation of the energy release in terms of an excited quantum vacuum. The argument was based

on a direct comparison between certain phenomena akin to sonoluminescence which have had already been tested with success as a possible means for fusion. Winterberg had also propose a similar model for a controlled fusion reactor based on very high current pulses.

The last serious attempt to an orthodox interpretation comes for Sergey Molokov [11, 12, 13] at Imperial College who uses a macroscopic approximation based on thermoelasticity and refuses the validity of pinch effects. While these have been shown to result in strong oscillations and longitudinal forces in open unconnected wires they can not explain the case of wires with clamped ends as is the case of all *closed circuits*.

This last case presents many similarities in the force formula obtained through Molokov's method and ours apart fro a geometric factor and we will discuss it further in the *Theory* section.

References

- [1] J. Nasilovski, Exploding wires 1964, v.3, ed. W.G. Chase and H.K. Moore, (New York: Plenum), p.295.
- [2] P. Graneau, *Longitudinal magnet forces?* J. Appl. Phys. 1984, v.55, p.2598.
- [3] P. Graneau, *Ampere tension in electric conductors*, IEEE Trans. Magn., 1984, v.20
- [4] P. Graneau, Wire explosions, Phys. Lett. A, 1987, v.120, p.77.
- [5] P. Graneau, *Ampere-Neumann Electrodynamics of Metals*, 1994, Palm Harbor
- [6] H. Aspden, *Phys. Letters* 107A N5 (1985) 238 – 240
- [7] H. Aspden, *Phys. Letters*, 111A N1-2 (1985) 22 – 24
- [8] M. Rambaut, J. P. Vigier, WO9116713
- [9] M. J. Taylor, *J. Phys. D: Appl. Phys.* 35 (2002) 700-709
- [10] F. Winterberg, *Annales de Fondation Louis De Broglie*, V31 N4 (2006)
- [11] S. Molokov, J. E. Allen, The fragmentation of wires carrying electric current, J. Phys. D, 1997, v.30, p.3131.
- [12] S. Molokov *et al.*, *J. Phys. D: Appl. Phys.* 36 (2003) 2757 – 2766
- [13] A. Lukyanov, S. Molokov, arXiv:physics 0012029v1
- [14] “Galilean Electrodynamics” Home : <http://home.comcast.net/~adring/>

Theory

1. Maxwell treatment of the fragmentation problem

In order to understand the Fragmentation Effect in terms of classical Maxwell theory we have to think of the conductors as macroscopic bodies with distributed electrical characteristics like admittances and reactances of a long transmission line. When an ordinary transient electrical pulse like those formed by capacitor banks with the usual exponential profile gets excited at the one end of the wire, the system may sustain an amount of stationary waves for the limited time interval of the initial disturbance.

These stationary waves would cease to exist if a steady state of the flowing current was to be established after several nanoseconds. Of course, in the case of a transient pulse there is no such effect and the current just stops flowing at an exponential rate. This is a distinction often met in systems that absorb energy from an external source as for example, a system of springs and masses undergoing driven oscillations by an external cause. In all such cases the full solution for the system dynamics (its evolution in time) is found to be composed by a *Transient* and a *Stationary* part of which the second is the one that prevails in the steady state of the system. On the other hand, the more violent the external perturbation is, the more violent oscillations may appear in the transient phase due to the demand imposed to the system for a radical reorientation of its internal state.

This can also be understood from a Thermodynamical perspective by stating that our system (the linear conductor – “wire”) is *Far-from-Equilibrium*. In such cases several quantities that are usually conserved may cease to do so due to the abrupt energy input. In our case though, only energy conservation breaks down while momentum and angular momentum are still conserved with respect to the center of mass of the system due to the fact that both ends are clamped to the external circuit. (We discuss the microscopic approximation in more detail in the next paragraph and in the *Simulations* section)

To simplify the discussion, we may for the transient phase that lasts for several nanoseconds (depending on the time constant given by the product $R \cdot C$ of the load resistance and the total capacitance of the circuit) consider the long linear conductor as a *radiating dipole*. The theory of such dipoles is well established in both theory and practice and this allows to perform a direct calculation of the near field around the conductor while ignoring the radiation (*far field*) for the limited amount of time of the transient pulse.

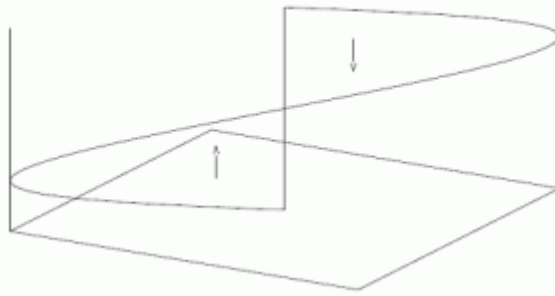


Fig. 1

There is then, a well established practice in Electrical Engineering for calculating forces which is similar with that used in electrical machines. One simply writes down the *reactive power* of the infinitesimal radiating dipoles and finds the force between adjacent dipoles around the nodes of a stationary wave as the “slope” of the *mutual reactive power*. This gives as a result, the total repelling force between such adjacent dipoles with opposite polarities. A generic formula obtained this way can be written in the generic form

$f = CI^2 \phi\left(\frac{L}{D}\right)$ where C is an appropriate constant, ϕ is a complicated geometric factor that can be evaluated numerically and L/D is the length to diameter ratio of the conductor. This formula has a great similarity with the one obtained by Molokov (see *History* section) apart from the ϕ factor. The differences though may be superficial as Molokov also uses a macroscopic theory based on a formalism of continuous media where the electromagnetic forces are introduced in an intermediate way. On the other hand, we are not very much interested in the case of hundreds of Kilo-Amperes and plasma formation as in his case. We actually intended to show that interesting effects where strong forces appear can be achieved with low amounts of energy and moderate values of the instantaneous current without even breaking the wires. Moreover, our model provides a clear and concise interpretation of the so-called “*longitudinal*” forces inside the conductors. These are simply *Coulombic forces between adjacent dipoles!* With this fundamental observation ceases any discussion on forces of unknown origin or mysterious extensions of electrodynamics.

It is easy to calculate the magnitude of such forces in the case of certain L/D ratios. An example of the total tensile force against this ratio is shown in the figure below

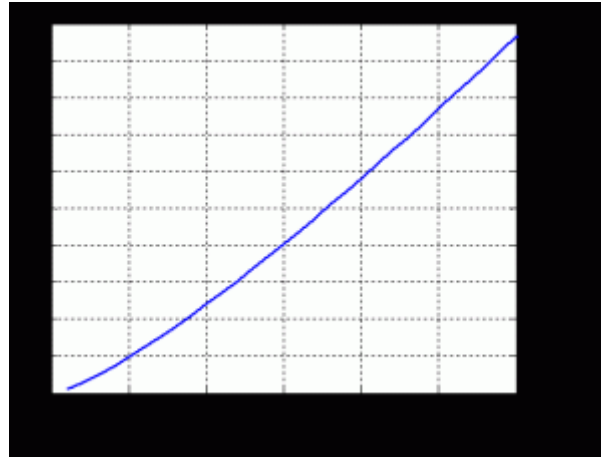


Fig. 2

An additional diagram of the force between individual dipoles as function of their distance from the center for a ratio of 200 is shown in the figure below

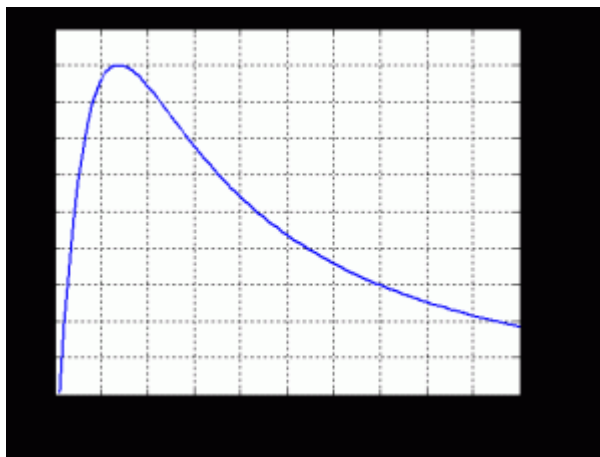


Fig. 3

In the next section we examine how could this theory be combined with the microscopic dynamics below the fragmentation threshold and in what way it could be utilized to enhance nuclear transmutations in unstable isotopes.

2. Applicability for LELANT (*Low Energy Lattice Assisted Nuclear Transmutations*)

While our original effort was towards a physical explanation of the “*exploding wires*” phenomenon, *the situation becomes much more interesting below the fragmentation threshold*. As our experiments showed, there are intense forces that get excited in wires and even whole metallic strips without breaking them but with unusual effects on the metallic structures. In principle, one could devise a linear conductor in such a way that its strength would be sufficient to carry a very large instantaneous current without breaking up. The true question then is what the influence of such transient pulses would be in both the electrons distribution and the ions inside the metal lattice of the conductor’s material.

One can use an unlimited amount of metallic alloys and compounds and even molten salts and use this technique for testing the behavior of different materials. One important question that we try to investigate with both experiments and simulations concerns the behavior of radio-active isotopes under such severe stresses. It has become known from previous reports that in certain experiments like those of Rambaut and Vigier a small amount of neutron radiation was released with the use of Lithium salts in heavy water.

It is not necessary that the conductor has to be fragmented or totally destroyed in order for inter-ion collisions to become strong enough. We will try to explain this later on based on a microscopic argument. We notice though that with an energy stored in the capacitor bank *not exceeding ~15 Joules* the applied power in such experiments may exceed the order of ~50 MWatts! What remains to be found are the region of parameters necessary for affecting nuclear transmutations (where by this we imply both fission and fusion reactions) including the externally applied voltage, the pulse durations, the geometry of the conductors used and the type of alloys that could serve as the “*fuels*“.

Now, the interesting thing about such a possibility is that such transmutations may in a sense appear ‘*cold*’! But this is not necessarily so and in fact this whole terminology may be entirely wrong (!) *as it only accounts for the macroscopic temperature of the conductor and not for the true distribution of the kinetic energies of both the electrons and the ions inside the metal lattice.* For an instantaneous effect like the “*kicks*” exerted with the aid of the transient pulses, there is no way to seriously increase the external temperature of the whole conductor as there is no time for equilibration to occur. On the other hand, an amount of both “*hot*” electrons and ions may still be present inside the material for a limited amount of time. We will now proceed to a more detailed -and a bit more technical!- examination of this problem (also check the *Simulations* section).

3. The transmutations that came from the ‘Cold’

A lot of words and ink have been spent the last two decades on the subject of *LENR* (*Low Energy Nuclear Reactions*) which originated in the famous Fleischman-Pons electrolytic experiment. We won't go into details with respect to this or similar experiments as it is not our main interest to discuss the issue of so-called “*Cold Fusion*” here. Rather, we want to criticize this terminology from the view point of today microscopic physics as we know it.

First of all, there can be no “*cold*” reaction. Whatever happens inside the electrodes of an electrolytic experiment or in our pulsed power device must be understood from the viewpoint of a statistical mechanical perspective as follows. Assume for a moment that an initial energy of 1 Joule is fed by some method into a composite system of many particles. Assume also that we ask the question on how many of these particles may attain a kinetic energy that would make them appear “*hot*” with respect to the rest. We remind that the effective temperature of these particles can be given by

$$T = \sqrt{2E / 3NK_B}$$
 where K is the Boltzmann constant and E is the kinetic energy. An ion for example would appear hot for a range of energies around 50 – 100 KeV. If we

divide the initial energy given to the system by the actual value of $1\text{eV} \sim 1.6 \times 10^{(-19)}\text{ J}$ we see that for 1 J of initial energy an enormous number of particles could attain at least 1eV of energy. This though would be so in a system that stays *near equilibrium*. In our case we are not just far-from-equilibrium (FE), we are actually *Extremely-Far-from-Equilibrium (EFE)* given that the initial pulse may have an effective power in the range from 10 – 100 MW!

For a system that undergoes such a violent redistribution of its internal energy, the matter of finding the true velocity and energy distributions is far from trivial. In condensed matter jargon one usually talks of the *Density-of-States (DOS)* of the system that comes from the imaginary part of the *Green's function* or *Inverse Hamiltonian Operator* that if known it allows to compute various other quantities statistically, that is by integrating over a probability distribution function like the *Fermi-Dirac p.d.f.* that governs all fermions (ions and electrons).

Unfortunately, in an *EFE* situation it is highly doubtful whether the Fermi-Dirac statistics has the same meaning as usual. In fact some of the distortions that appear in the conductors during our experiments are so severe that may even make the band structure to collapse thus turning the metal into a locally amorphous state. We also ignore for the moment the possible role of defects (like dislocations) that surely exist in a macroscopic crystal. In any case, one should expect a serious distortion of the initial equilibrium distributions.

It is now this distortion that justifies our hope for LELANT to occur. We know that when a current passes through a conductor the velocity distribution is '*shifted*' as well as the *Fermi Sphere* of energies. We also know that eg. fission reactions will certainly occur near energies of the order of 100 KeV to occur by nucleus destabilization (*liquid drop model*). We may then propose the following condition for LELANT:

A sufficient condition for LELANT is a shift of the velocity distribution such that the tail of the distribution from the right reaches a range that allows a high probability of "tunneling" through the Coulomb barrier.

The amount(%) of the distribution that covers a critical "hot" range (say above 50 KeV) is what effectively defines the final "*reaction rate*". For an unstable isotope this would mean an increase in the rate of burn out towards stable isotopes while in a Lithium-Lithium or Lithium-Deuterium reaction would manifest in the overall neutron and radiation release depending on the type of reaction and its byproducts.

A (classical) way to find such distributions is given by *Boltzmann Kinetic Theory* in which the overall result of the external forces on the distribution of an EFE system is described through an equation known as the Boltzmann Equation. In simple terms it equates the total time differential of the PDF in a 6-dimensional space of positions and momenta (including a "convective" term) with the overall collision rate due to scatterings. It is more like a pseudo-"Navier-Stokes" operator acting on an inviscid probabilistic "fluid" in that 6-dim. space. Solutions of this equation relate in a formal way an initial state which is the equilibrium PDF with the finally achieved distribution function. What the LELANT condition then actually says is that if the solution of such a problem allows for ions to attain such high kinetic energies the

probability of tunneling and thus of nuclear transmutations is accordingly high. We may see this as a shift to the right of the distribution shown in the figure below where we have used blue color for the initial state and green for the final distorted one.

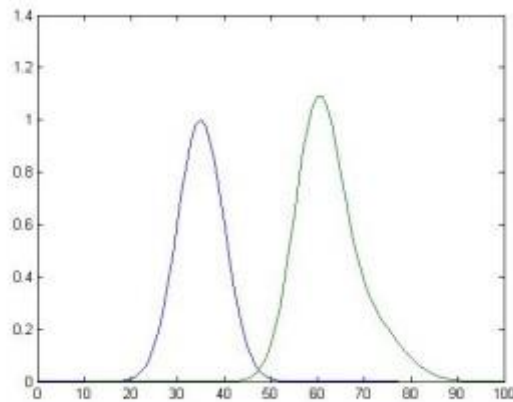


Fig. 4

People have devised a variety of techniques to compute such distorted distributions over the years. These include (i) *Boltzmann Transport Theory* (both *Classical and Quantum*) that can be solved using either analytical (very difficult!) or numerical techniques like *Monte-Carlo/Molecular Dynamics*, (ii) *Non-equilibrium Green Functions* (NEGF) that have been mostly developed for nano-devices.

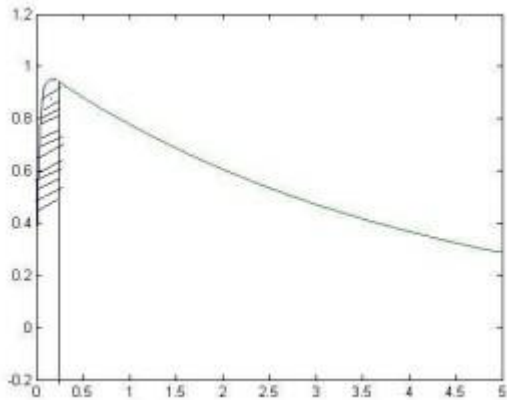
A second serious difficulty with such techniques concerns the fact that a macroscopic conductor constitutes a *Many-Body Problem* with an enormous number of Degrees-of-Freedom (*DOF*). For example, the case of NEGF has only been used for microscopic conductors or combined semi-conductor devices in the nano-scale. If it was to use such a technique here the computation would never end! Instead one can use either a semi-classical approximation based on a *Molecular Dynamics* scheme or a *Monte Carlo solver* of the Boltzmann Transport Equation.

Another solution for the problem of the macroscopic system can be given with the aid of a *Transfer Matrix* approach which is similar in spirit with the picture of the macroscopic system as a long transmission line with distributed characteristics. In this case one may solve for eg. the *Collision Kernel* using Monte Carlo or other solvers inside a small section (“slab”) of the conductor given appropriate boundary conditions and then propagate the information of the initial shock across a known band structure.

Analysis

“Do not seek to follow in the footsteps of the men of old; seek what they sought.”
- Matsuo Basho, 16th century Japanese poet

For an accurate analysis of the pulsed excitation including the near field radiation stage one is faced with a very difficult problem. One way to treat this is to separate the whole phenomenon into two stages. This is shown in the following figure



where we have separated the electrical pulse into two main stages (the curve is a bit exaggerated to show the details). We assume a first stage of a very fast rise time of the form say $1 - \exp(-t/RC)$ and a second stage of an exponential decay $\exp(-t/RC)$. The units are arbitrary and one could in fact use units of 1-10 KV max. values or higher to excite the conductor from an appropriate capacitance bank or even a *Marx Generator*.

The reason for such a distinction is to separate the problem into two stages with respect to the initial “kick” in the absence of stationary waves and the rest of the transient where stationary waves finally appear for several nanoseconds. This lead to the notion of an “ideal pulse” defined with respect to the max. propagation velocity of an initial EM Shock wave inside the lattice before some part of it will get reflected to the other end. Such a propagation is a complicated issue in as much as it involves the secondary emissions from the lattice itself.

For the moment we may assume that this velocity will be a significant fraction of the vacuum propagation field velocity c . Taking copper as an example we may assume an average velocity of say 2×10^8 m/sec. Thus, if what we want is the rise time of the first stage of the pulse to complete before the advent of the first reflected wave than the time constant RC must be at least of the same order as the time it takes for the initial EM pulse to traverse the conductor and reach the other end. For a conductor length of 1m this gives $RC \sim 0.5 \times 10^{(-9)}$ secs. Taking into account that we also want a very low internal resistance of the whole circuit in the milliohm range then the capacitance falls in the μF range which is not an unnatural assumption.

Let us now simplify the microscopic analysis by restricting attention to a simple 1-Dimensional lattice with ordinary Coulomb-like ionic potentials. Then, at the first stage both the ions and the electrons would have to suffer a perturbation of the form $H' = qE(t)z$. **The main difference is that due to the very high ions/ electrons mass**

ratio and at the same time the momentum conservation of the whole conductor there will be a strong asymmetry in their motion and as a result into the overall lattice polarization.

For the very short time of the initial “kick” stage we may ignore the result of the secondary emissions of both the ions and the electrons. We may also assume that at this initial stage of the first *phonon* formation, the ions are moving in the opposite direction than the electrons following the applied field, completing half of their oscillation amplitude to preserve total momentum so that the ratio of total ions/electrons momenta is roughly analogous to the ions/electrons mass ratio.

The other important fact in this simplified picture is that Hamiltonians with such an external perturbation have already been analyzed for the last fifty years or more and the results were tied with a phenomenon known as the “*Wannier – Stark Ladder Effect*” where the eigen-energies of the system take the form of a “staircase. There are also other important effects like hopping of carriers and increased coherency. This has already been associated with *Superlattices*, a fact that may suggest the appropriate use of layered structures in the conductors used in our experiments. A pedagogical example is given in the publication [Q. Thommen *et al.* “*Quantum interference in a driven washboard potential*”, *Am. J. Phys.* **72** (8), 2004, 1017 - 1025] and a more detailed treatment based on Green’s function in [Ryan A. English, PhD Thesis, Univ. Waterloo (1997)].

The second stage is much more difficult to analyze. The main difficulty stems from the fact that not only does the external field continues to feed the system with energy but also that the secondary emissions have to be taken into account. The fact that stationary waves may appear at this stage has to be linked with a phenomenon of “*neutrality breakdown*” of the lattice. The reason is that apart from the externally applied field of the pulse *a new Vector Potential must be added in order to justify the appearance of the macroscopic near field.* In fact the field of a radiating dipole is too difficult to analyze microscopically as long as one would also have to take into account even the presence of *virtual photons* from a complete quantization of the EM field. Ignoring this, we may try to write a simplified picture which must then be accompanied by an appropriate *Self-consistency condition*. We may attempt to provide such a picture as follows

$$H = -\frac{\hbar^2}{2m} \left(P - \frac{e}{c} \mathbf{A}(x, y, t) \right)^2 + V_{\text{Internal}}(r_i - r_j) + q(E_0 z e^{-1/\lambda c} + \nabla \Phi(r, t))$$

$$\Phi(r, t) = Z_{\text{ion}} \sum_{\text{ions}} \frac{1}{r_{\text{ion}} - \mathbf{b}_{\text{ion}} \bullet \mathbf{r}_{\text{ion}}} \Big|_{\text{ret}} - e \sum_{\text{ions}} \frac{1}{r_e - \mathbf{b}_e \bullet \mathbf{r}_e} \Big|_{\text{ret}}$$

$$\mathbf{A}(r, t) = Z_{\text{ion}} \sum_{\text{ions}} \frac{\mathbf{b}_{\text{ion}}}{r_{\text{ion}} - \mathbf{b}_{\text{ion}} \bullet \mathbf{r}_{\text{ion}}} \Big|_{\text{ret}} - e \sum_e \frac{\mathbf{b}_{\text{ion}}}{r_e - \mathbf{b}_e \bullet \mathbf{r}_e} \Big|_{\text{ret}}$$

where the last two equations are the self-consistency conditions summing up the Lienard-Wiechert potentials from the individual emissions of ions and electrons. A typical vector potential for a stationary wave inside a material with a refractive index n would have to be of the form

$$\mathbf{A}(r, t) = 2A_0 \cos\left(\frac{kz}{n}\right) [\sin(\omega t)\mathbf{i} - \cos(\omega t)\mathbf{j}]$$

Even this problem is too difficult to handle analytically but it could serve as a starting point for a more detailed atomistic simulation. Based on our main assumption one should then try to show that as the first phonons form inside the lattice a number of them representing head-on collisions of ionic nuclei may obtain such high velocities locally that the probability of tunneling becomes significantly high. The question concerns also the microscopic analysis of the influence of such stationary waves on the local fluctuations of the polarization field and the magnitude of the local stresses on the stresses on the lattice structure.

“Atoms-in-Molecules” : R. F. W. Bader’ s alternative viewpoint

There is an interesting alternative in circulation for the last 40 years that applies to atoms seen as open systems. It has been developed by prof Richard Bader (Chemistry Dept. McMasterUniv.) and it is contained in the main publication [*Atoms in Molecules: A Quantum Theory*. USA: Oxford University Press (1994)].

In AIM, an atom is considered as a “*proper open system*” that shares energy and charge density localized in the surrounding space. Atoms then become “attractors” for the charge density and their study is reduced in the study of the geometrical characteristics of the charge density with emphasis on the local curvature. There are a number of important theorems that AIM has provided like the *Atomic Force Theorem* and the *Quantum Stress Tensor Density*.

Is there a possible role for an external magnetic field?

There is an additional question that has been put by other researchers in the field of “*cold*” transmutations. Dr Iyengar that has worked for about 20 years at the Bhabha Research Center of India has noticed that in a number of experiments an external magnetic field seemed to be able to lower the Coulomb barrier. One possible experiment towards this direction could be done with a metallic strip surrounded by two *Helmholtz Coils* in such a manner that macroscopically the resulting magnetic field would satisfy $\mathbf{J} \times \mathbf{B} = 0$ (with the main axis of the two coils aligned with the strip conductor).

One then could imagine a scenario at which a percentage of the ions been more or less oscillating around their equilibrium positions, they become aligned with the external field at least near the surface of the conductor via their magnetic moments (assuming isotopes with non-zero μ). If there was an appropriate type of polarization and/or an appropriate way of building the “fuel” material of the conductor in such a way that the electron clouds of the interior shells would leave part of the ionic nuclei bare naked then the possibility of a reactive scattering would possibly increase dramatically.

Experiments

1. General description

In order to prove the existence of strong ionic collisions inside thin wires a special pulse generator was designed. The basic circuit is shown in Fig. 4. The aim behind this design was to have the overall internal resistance of this circuit to lie in a range of some $m\Omega$'s. For this, a special set of capacitors and a thyristor of very low internal resistance were chosen.

The current pulses were created by the discharge of the capacitor bank composed of 4 capacitors in parallel, each of $3 \mu F$ with $12 \mu F$ total capacitance (4.3), with the aid of a special digital controller circuit (4.6) that allowed both a single pulse or a sequence of consecutive pulses (see Fig. 4). The actual device is shown in Fig. 5. The duration between subsequent pulses in the sequential mode was of the order of 3 secs. These were then applied to a variety of wires of variable diameters and a constant length of approximately 27 cm.

The exercised voltage of the capacitors was nearly $1000 \div 1200$ Volts and the discharge resistances including the circuit and the additional wire resistance were from $100 m\Omega$ to $300 m\Omega$. The time constant of the occurring discharges were thus in the range of several μ secs.

The values of the instantaneous currents exerted on the wires from these current pulses were in the range of $4000A$ - $12000A$. It was not possible to measure the magnitude of the fundamental harmonic but its existence could be detected by the appearance of longitudinal vibration of the thin wires that could be detected visually and easily could be captured by a high resolution camera.

Direct inspection showed that during the first pulse, a cloud of metallic dust gets violently expelled from the wire surface. This is speculated to be the result of the bipolar forces on defects and dislocations in the metallic crystal lattice. After several pulses depending on the wire diameter some of the wires get cut not necessarily near the center of the total length. This apparent discrepancy with the theoretical prediction of section 2 is probably due to the simultaneous coexistence of several different wavelengths due to the continuous spectrum of the discharge curve.

A number of wires with a steel core and a conductive metallic layer deposited with an electrolytic bath were also tried to show that it is possible to increase the tensile strength to avoid fragmentation. Indeed, the type of fatigue of the conductive metallic layer remained the same although the wire did not get cut despite a large number of pulses applied sequentially for a long time interval of several minutes up to half an hour.

In particular, the specific type of fatigue appearing in a set of experiments with copper wires of 27cm length and an average resistance of $300 m\Omega$ was shown to be characterized by three major effects.

- a) A number of almost periodic burns on the external surface of the wire that is probably associated with the wavelengths of higher harmonics.
- b) An overall zig-zag shape obtained by a loose wire and a subsequent length shortening that is strongly suggestive of the opposite local dipole polarities, due to the action of several harmonics, at certain sections of the wire.
- c) At some of the experiments sparks appeared to emanate from points of the surface totally unrelated with the final break point. Some of these were captured with the video camera and may be related with local charge concentrations on previously created cracks of the metal surface.

Observation of the condition of the wires surface took place at the Laboratory of Metallurgical Microscopy of the National Technical University of Athens. Results were photographed and are shown in the pictures of Fig. 6. Examination of these samples revealed both vertical as well as helical cracks on the metal surface.

Another question concerning the appearance of the characteristic “neck”-like configuration of a metal near the break point due to increased metal plasticity as usually predicted was not verified. The final breaking mechanism may require separate study but our purpose in these experiments was rather to prevent the wires from reaching their tensile strength threshold in order to create a sustainable mechanism for exerting bipolar forces on a metallic lattice without breaking.

2. Videos

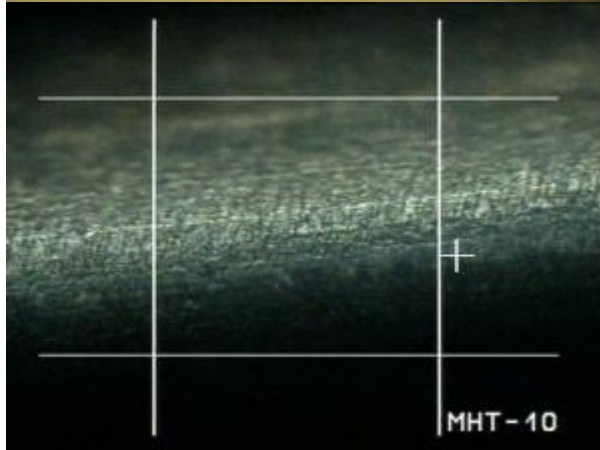
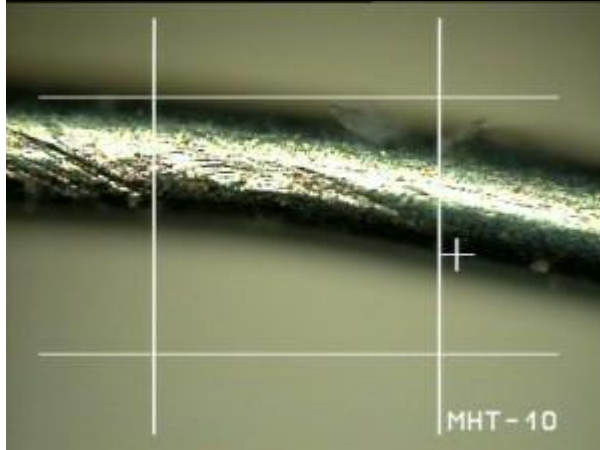
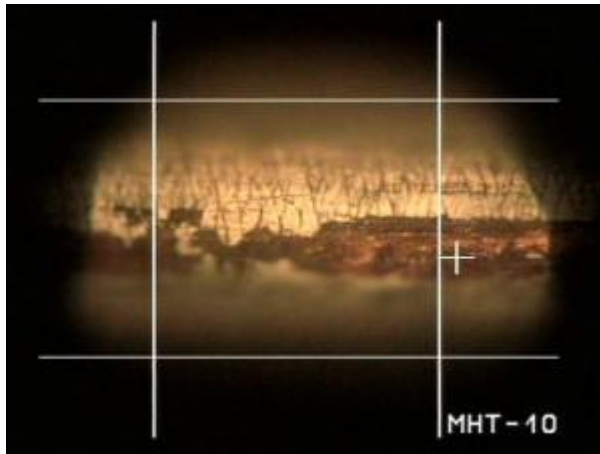
[MOV01122](#) : MPEG file showing the strong vibrations on a copper wire under a sequence of 1.2 KV pulses.

[MOV01123](#) : Same experiment as above which shows a small spark near the top of the wire a little before the final breakdown near the bottom.

3. Photos form Metallographic Microscope (NTUA)

In the images below we show the type of fatigue observed on the surface of the wires after exposure into an amount of several high voltage pulses (10 – 30). There are both helical and vertical cuts while part of the metal is violently expelled.

(Special thanks to prof. Vasiliou Panagiota of NTUA for her support in preparing the wire photos in the Laboratory of Metallurgical Microscopy of the National Technical University of Athens)



4. Photos of the device used

(Special thanks to electronic engineer George Bindarchas CEO of “ELCON Systems & Components” for the construction of the electric pulse generator and his support during the experiments)



more material to be added soon...

Simulations

Mesosopic – microscopic simulations

An attempt to locate a range of optimal parameters for LELANT in a variety of materials and compounds is ongoing through detailed atomistic simulation using a variety of existing techniques. Possible candidate “*fuels*” that are currently examined include Li – Li reactions, Th – Li and molten salts of Th and Li Deuterides.

(Special thanks to prof. Dragica Vasilescu of Arizona State University for her contribution of the Monte Carlo Solver for Boltzmann equation, to Dr Vasilios Raptis of the University of Ioannina and Aiki Vegiri of the National Hellenic Research Foundation for their cooperation in the Molecular Dynamics Simulations.)

1. Boltzmann Transport Equations (Phonon – electron interaction)

(material to be added...)

2. Transfer Matrices and Band Structure

(material to be added...)

3. Non-equilibrium Molecular Dynamics

3a. Molten Salts

3b. Alloys

Downloads

Publications

[1] C. D. Papageorgiou, T. E. Raptis, “*Fragmentation of Thin Wires under High Voltage Pulses and Bipolar Fusion*”, 7th International Conference of the Balkan Physical Union. AIP Conference Proceedings, Volume 1203, pp. 955-960 (2010).
[\[PDF\]](#)

[2] C. D. Papageorgiou, T. E. Raptis *Dipole Electromagnetic Forces on Thin Wires under Transient High Voltage Pulses* Europ. J. App. Phys. 48, (2009) 31002
[\[PDF\]](#)

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