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EDITORIAL: PEER REVIEW AND EDITOR'S CHOICE

Harold L. Fox

In U.S. Patent 5,018,180 (the inventor is Kenneth R. Shoulders and the title is "Energy Conversion Using High Charge Clusters") this statement is made concerning the ability to produce over thirty times as much energy out compared to energy in: "In any event, energy is provided to the traveling wave output conductor, and the ultimate source of this energy appears to be the zero-point radiation of the vacuum continuum." At the present time, insofar as this editor can determine, no one in the world (except possibly one scientist in Minsk) is producing high-density charge clusters except Ken Shoulders and his son Steve. Assume they send a paper to this journal describing their latest work in developing this new technology, **where do we find a peer?** This can be a major editorial problem.

Our solution to this problem is to have nearly all of the papers we receive immediately sent for peer-review. Our policy includes providing the author with the names of the reviewer(s). Some selected papers are not sent for peer review but are published under the heading of **editor's choice**. The **editor's choice** of papers can stem from either the lack of a peer; a paper submitted by a well-known and respected scientist with experimental findings that merit immediate publication; a paper for which the editor desires to have a wider "review audience"; or an occasional student's paper. **In all cases the editor's choice papers will be clearly identified as such.**

In this second issue of the *Journal of New Energy*, we have exercised the **editor's choice** to bring to you a discussion of many years of privately-funded experimental work in the creation of hydrogen. We have chosen to name the effect **the Rowe Effect**. Rowe's discovery is that abrupt energy produces hydrogen. Rowe's explanation is that the energy causes the vacuum to retaliate with the production of electron-proton pairs. This editor has extended the concept of the **Rowe Effect** to explain the penetration of the Coulomb barrier.

Another **editor's choice** is the paper by a sixteen-year old high school student, Taylor Hartley. The printing of Taylor's paper is meant to be an honor for him and also to encourage other young science students.

We are pleased to announce that the third issue of the *Journal of New Energy* will include the proceedings of the planned September 13-14, 1996 second conference on Low-Energy Nuclear Reactions. All conference presenters are being asked to bring their papers on diskette to the conference so that immediate publication of the proceedings can be accomplished. Some of the papers to be presented deserve immediate publication because of the reports of experimental findings of a plethora of low-energy nuclear reactions.

WATER MOLECULES CONVERSION IN LOW PRESSURE DISCHARGES

E.E. Antonov, V.G. Dresvyannikov, V.I. Popovich[1]

ABSTRACT

The problem of hydrogen utilization in stationary and transport engines, including the hydrogen obtained by decomposition of water molecules, has lately been intensively investigated. It is known that the addition of 3-5% H_2 to air-gasoline mixture improves the efficiency of automobile engines owing to the increase of fuel-mixture ignition range. It increases combustion knock stability, and essentially improves the ecological characteristics of engine without the decrease of its power. In such a way it is possible to use the poor gasolines, to reduce the gasoline consumption by 20-30% and to increase the fuel efficiency of engine by 10-15% [1]. Some authors have developed the practical systems for hydrogen production in which the direct decomposition of H_2O molecules to gaseous mixture ($H_2 + O_2$) by electrolysis in liquid phase took place [2]. This method realizes the conventional mechanism of water molecules dissociation:

$$H_2O \rightarrow H_2 + 1/2\ O2$$

with activation energy E_a = 2.6 eV/mol. Minimum energy consumption for this process even for laboratory installations is 7-8 kW hour/m^3, process efficiency does not exceed 40% [3].

The main aim of our research was the investigation of water dissociation mechanisms in a gaseous phase with the participation of vibrationally-excited H_2O molecules, the determination of charged components composition, and the degree of vibrational non-equilibrium of the system in dependence on the energy supplied into the discharge. These data are necessary for optimization of water conversion processes and for creation of on-board devices for hydrogen production from water by high-voltage electrical discharges.

INTRODUCTION

Plasma-chemical discharge methods of water conversion in gaseous phase are more effective for hydrogen production. Their power efficiency is comparable with electrolysis. Thus, the energy consumption for producing one m^3 of hydrogen by plasma-chemical method is 3.5-4.0 kW hour but their specific efficiency (per unit mass of installation) exceeds electrolysis efficiency [3]. In such a manner, the high rates of plasma-chemical processes and the opportunity for creation of low-volume simple devices with small metal consumption and high specific productivity are provided.

One more advantage of the plasma-discharge method compared to electrolysis in the potential of its application for on-board automobile devices is the opportunity of utilizing part of thermal energy of air-gasoline combustion products for the conversion of water from the liquid phase to the gaseous one. For usual motor-car engines this heat, which constitutes up to 30-35% from the energy of fuel combustion, is dissipated into the environment.

The analysis of scientific-technical data shows that the dissociation of H_2O molecules in discharge plasma conditions is provided, basically, by two mechanisms:

(i) by vibrational excitation of water molecules by electron impacts with the subsequent decay of these molecules:

$$\begin{aligned} H_2O + e &\rightarrow H_2O^* + e \\ H_2O + H_2O^* &\rightarrow H + OH + H_2O \\ H_2O^* + H &\rightarrow H_2 + OH \\ H_2O^* + OH &\rightarrow H + H_2O_2 \end{aligned} \qquad (1)$$

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and (ii) by dissociative attachment of electrons to water molecules:

$$H_2O + e \rightarrow H^* + OH$$
$$H^* + e + M \rightarrow H + 2e + M \qquad (2)$$

where M is water molecules and/or water conversion products.

The contribution of each of these two reaction channels to the total rate of water molecule conversion is determined by the parameters of the plasma reactor. First of all, by the temperature of electrons T_e, by vibrational temperature of water molecules T_v, by translational temperature T_g of gas, and by concentrations of the electrons n_e and of the positive n^+ and negative ions n^-.

For $T_e < 1.5$ eV the mechanism (i) is the more effective. With the increase of electron temperature T_e, the contribution of dissociative attachment (ii) is essentially increased. The relative contribution of the water decomposition mechanisms (i)-(ii) shown above becomes comparable at electron temperature T_e:

$$T_e = \varepsilon_o \ln^{-1} (k_a \varepsilon_0 / k_{ev} \varepsilon_{vo}) , \qquad (3)$$

where ε_o is the energy corresponding to resonant maximum of the cross-section for dissociative attachment of electrons to H_2O; ε_{vo} is characteristic vibrational quantum of H_2O molecules; k_a, k_{ev} are reaction rate constants for dissociative attachment and for vibrational excitation, accordingly.

The total efficiency of dissociation mechanisms (i)-(ii) can be equal to 60-70% [2,3]. However, practical realization of above plasma-chemical methods has some difficulties. One of the most important problems is the necessity to maintain certain plasma parameters in the reactor: high degree of ionization n_e / n_m at low electron temperatures $T_e \cong$ 1-3 eV, and the separation between vibrational temperature T_v and the gas temperature T_g at high pressure of the gas P_g in the reactor. It is difficult to conduct detailed analysis of water dissociation mechanisms in the discharge for its optimization, because information in the literature about water plasma properties is practically absent. Some publications (see, for example [4]) contain only single data about H_2O vapor discharges.

THEORETICAL MODEL

The main reactions of generation and degeneration of charged particles for plasma-discharge water vapor are determined by the distribution of the energy supplied into the discharge between the components of the plasma process. The channels of energy transfer can be represented by the following scheme:

$$\{n,T,\} \xrightarrow{(I)} \{n^*,Tv\} \xrightarrow{(II)} \{nm, Tg\}$$
$$(jE) \downarrow (III)$$

Channel (I) is the power (jE) supplied into the discharge which is used in the excitation of vibrational levels of H_2O molecules:

$$JE = n_m n_e k_{ev}. T_e , \qquad (4)$$

where j is the density of discharge current; E is the strength of electrical field in plasma; n_m, n_e are the concentrations of water molecules and electrons, accordingly; k_{ev} is the reaction rate constant for vibrational excitation of water molecules by electronic impact.

Channels (II)-(III) are the energy fluxes determining the losses of energy of vibrationally excited molecules: channel (II) is the process of vibrational-translational (VT) relaxation, and channel (III) is the diffusion of vibrationally-excited molecules to the walls of discharge volume.

Thus, the equation for vibrational temperature of molecules T_v in stationary mode is determined by the balance of energy flux for the excitation of vibrational levels of H_2O and by the relaxation processes:

$$JE - n_m / \tau_{vt} \{\varepsilon_v(T_v) - \varepsilon_v(T)\} - \Delta g_v = 0 , \quad (5)$$

where $\tau_{vt} = k_{10} \cdot n_a \{1-\exp(-\varepsilon_{vo} / kT)\}$; k_{10} is the reaction rate constant for vibrational excitation; n_a is the density of the component, on which the relaxation of vibrational excitation of H_2O molecules takes place (in the case of small discharge currents $n_a \cong n_m$); $\varepsilon(T_v)$ is the average vibrational energy for one water molecule at vibrational temperature T_v; ε_{vo} is characteristic value of vibrational quantum of H_2O molecule; $\Delta g_v = Q_v(T_v - T_o) / D_o^2$ is the energy flux determined by the diffusion of vibrationally-excited water molecules to the walls; Q_v is the heat transfer coefficient for vibrationally-excited H_2O molecules; D_o, T_o are the diameter of discharge tube and the temperature of its wall, respectively.

For the determination of gas temperature T_g we shall consider that the process of heating neutral gas due to the interaction with vibrationally-excited molecules (channel II) is counterbalanced by the process of heat-exchange between the gas and the cooled walls of the discharge tube, (channel II). In this case the equation for gas temperature T_g can be recorded in the form:

$$n_m / \tau_{vt} \{\varepsilon_v(T_v) - \varepsilon_v(T_g)\} - \Delta g_t = 0 \quad (6)$$

where $\Delta g_t = Q_t (T_g - T_o) / D_o^2$; Q_t - the heat-exchange coefficient for components $n_a = n_m$.

In the above conditions, the set of non-elastic processes occurs in the plasma volume, which together with the processes of energy exchange, determines the ionization-recombination balance of the discharge. We will consider only the most essential data from this process as listed in the following Table 1.

1.	$e + H_2O \rightarrow H_2O^+ + 2e$	$k_i = k_i(T_e)$	Rate constant for H_2O molecules ionization by electron impact
2.	$e + H_2O \rightarrow O^- + H_2$ $e + H_2O \rightarrow H^- + OH$ $e + H_2O^* \rightarrow O^- + H_2$ $e + H_2O^* \rightarrow H^- + OH$	$k_a = k_a(T_e)$ $k_a^* = k_a(T_v)$	Rate constant for dissociative attachment of electrons to H_2O molecules
3.	$O^- + H_2O \rightarrow OH^- + OH$ $H^- + H_2O \rightarrow OH^- + H_2$	k_c	Rate constant of conversion of O^- and H^- ions into the stable ion OH
4.	$O^- + H_2O \rightarrow O + H_2O + e$ $OH^- + H_2O \rightarrow OH + H_2O + e$ $H^- + H_2O \rightarrow H + H_2O + e$	k_d	Rate constant for destruction of negative ions O^-, OH^-, H^-
5.	$H_2O^+ + e \rightarrow OH + H$ $H_2O^+ + e \rightarrow H_2 + O$	k_{ei}	Rate constant for electron-ion recombination
6.	$O^- + H_2O^+ \rightarrow O + H_2O$ $OH^- + H_2O^+ \rightarrow OH + H_2O$ $H^- + H_2O^+ \rightarrow OH + H_2$	k_{ii}	Rate constant for ion-ion recombination

For the determination of charged particles concentration, n_e, n^- and temperatures T_e, T_v and T_g, for the stationary mode of water vapor discharge, the equations (4)-(6) should be aided by the steady equations of charged components density and by the condition of plasma quasi-neutrality

$$k_i n_m n_e + k_d n_m n^- - k_a n_m n_e - k_a^* n_e n_m^* - k_{ei} n_e n^+ = 0 \quad (7)$$

$$k_a n_e n_m + k_a^* n_e n_m^* - k_d n_m n_e - k_{ii} n^- n^+ = 0 \quad (8)$$

$$n_e + n^- = n^+ \quad (9)$$

where $n_m^* = n_m^{(-\varepsilon / kTv)}$.

Equation system (4)-(9) does not take into account the ionization of water molecule conversion products and the number of non-elastic processes between neutral plasma components. Such approximation is valid for a small proportion (<10%) of dissociated water molecules.

This system of equations (4)-(9) was solved numerically. The density of discharge current and the rate of negative ions destruction were independent variables. In such a manner, we take into account the possible influence of plasma conditions on the generation of useful product. The detailed description of the above model and the reaction rate constants used for the plasma-chemical processes considered can be found in [5].

The theoretical data obtained were compared with experimental results to test the adequacy of the proposed model. The results of numerical calculations for some experimentally investigated modes of discharge are shown in Table 1.

EXPERIMENTAL RESEARCH

For the investigation of water conversion processes in the gaseous phase under the influence of high-voltage electrical fields in both stationary and pulsed modes, the experimental installation was designed and made. A block-diagram of this set-up is shown in Fig. 1. This installation is a complex array of equipment and devices for generating and handling the computer monitoring of the discharge plasma as well as recording the products of plasma-chemical decomposition of water molecules.

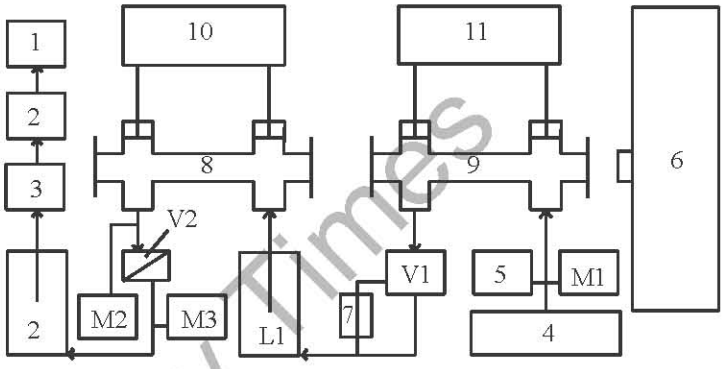

Fig. 1. Block-diagram of experimental installation.
1 -initial-vacuum pump; 2- high-vacuum diffusion pump; 3- vacuum valv
4- cryostat with water; 5- deformation-type manometer VDG-1; 6- set-up
spectral diagnostics; 7- calibrated capillary; 8- measuring cell; 9- discharg
tube; 10, 11- power supply blocks; MI, M2, M3 - thermocouple manomet
LI, L2- liquid nitrogen snares; VI, V2 - adjustable vacuum valves.

At the initial stage, the experiments were conducted at P_g = 0.1-20 Torr. Such low water vapor pressures were chosen to facilitate the analysis of plasma-chemical processes and to find out the conversion mechanisms, because for such conditions it was possible to carry out the above numerical calculations and the comparison of experimental and theoretical data.

All experimental research was performed in discharge tubes made from molybdenum glass. Water in a liquid or solid phase was contained in a special container which was placed in the cryostat. The necessary water vapor pressure and the temperature of the cryostat were adjusted by a special thermoelectrical control circuit. Water vapor pressure was determined by thermocouple M1 and deformational VDG-I manometers. The vacuum system for the pumping of the discharge device included the initial-vacuum pump 3NVRID, the high-vacuum diffusion pump H-100 and the system of vacuum valves for the controlled input of water vapor and for the determination of water dissociation products. The glass snare [trap] L1 with liquid nitrogen was provided in the above vacuum system and was used for freezing the water vapor from the discharge volume.

The gaseous products of H_2O decomposition of water molecules (O,OH,O_2,H_2) through the trap L1 and valve V1 flow to a special measuring cell. This cell design was almost identical to the discharge tube. By initiating the discharge in the measuring cell, it was possible to monitor the structure of dissociation products and their concentrations by observing the spectrum of their optical radiation. The pressure in the measuring cell was measured by thermocouple manometer M2. From the measuring cell, the gaseous water dissociation products arrived at the calibrated valve V2 where an additional thermocouple manometer M3 and cold trap L2 were used. The water vapor which passed through the first cold trap L1, as well as the water formed in the measuring cell (due to plasma-chemical reactions) were frozen in trap L2. The difference between the two manometers M2 and M3 characterized the gas flux Q_m of gaseous products of H_2O conversion flowing through the valve V2. This flux value was designed by standard methods [6].

The electrical steady discharge was created by a high-voltage stabilized power supply (4 kV, 90 mA). For the relaxation measurements and for the study of the mode of development of water vapor discharge, the specially-designed pulsed power supply was used which formed the rectangular pulses of current with amplitude 5-200 mA, duration 0.01-5.00 ms, and recurrence frequency of 50-1000 Hz.

The plasma parameters were determined by a system of electrical probes. Thus, the electrical field strength E on the axes of the discharge and the concentration of charged plasma components were monitored.

The radiation of the discharge plasma was used for spectral diagnostics of water vapor dissociation products by the diffraction monochromator MDR-23 using a photomultiplier tube FEU-100 (for visible region) or FEU-62 (for infrared). For these measurements, special optical windows from sapphires were provided in the end faces of the discharge tube. In some regimes the modulation of the light beam was used to eliminate scattered background radiation. Electrical signals from FEU, proportional to the radiation flux, were supplied to the computer IBM PC 486 DX66 that allowed us to regulate all discharge parameters and to automate the logging and processing of experimental data.

The above set-up and experimental techniques are described in detail in [5]. This installation and computer data monitoring system appeared to be especially convenient for measuring the experimental data processed in the pulsed discharge mode.

RESEARCH RESULTS

The measurements of water-vapor plasma discharge radiation spectrum, for gas pressures of P_g = 1-10 Torr and discharge currents of I = 1-90 mA in steady and pulsed modes, were performed. The main purpose of such measurements was the determination of the spectral structure of H_2O plasma radiation for wavelengths of 200-800 nm and the identification of the radiating molecules and radicals.

The characteristic radiation spectrum of steady water-vapor discharge is shown in Fig. 2. The analysis of the spectrum indicates that in the near ultraviolet area (150-400 nm), the continuum of molecule H_2 and strong molecular bands of the OH radicals dominate. In the visible area (400-650 nm) the radiation intensity of water plasma is too small to monitor. In this case, the apparent small visible brightness of the discharge column was monitored. This range of spectrum uses the atomic lines of the Balmier-series of hydrogen and the bands of molecular hydrogen down to 800 nm. In long wave-length spectrum area (more than 650 nm), it is possible to allocate the molecular band with a center close to 692.2 nm and atomic line OI with wavelength 777 nm. The above band corresponds to the H_2O molecule radiation spectrum [4]. Thus, there was the opportunity to identify the concentration of main primary products of water vapor conversion in discharge (radicals H, OH, O and molecules H_2O and H_2) by optical non-contact methods.

For steady glow discharge in water vapor at pressure P_g = 0.7-4.0 Torr and using discharge-current densities j = 1-30 mA/cm^2, the rate of generation of H_2O molecules conversion products was measured and compared to the energy supplied into the discharge. In these measurements the value of discharge current is I; the electrical field strength E; specific power W_z supplied into the unit length of discharge tube; pressure in plasma reactor P_g; and the gas flux Q_m from the discharge zone have been monitored. The density of H_2O molecules dissociation products was also registered by optical methods. Some of these results are shown in Fig. 3. It is obvious that the flux Q_m of stable water-vapor conversion products from the reaction zone versus the power W_z has the same character in all investigated pressure ranges. At the initial stage, the linear increase of dissociation products occurs, then the saturation and some reduction of gas flux occurs. The optimum value of power W_z for the generation of conversion products (H_2+O_2 mixture) is determined as well as the optimum power for radicals (first of all, H and OH) is also determined.

The optimum value of power W_z is increased with the increase in water pressure. This reflects the increase of longitudinal electrical field E in the plasma. However, the magnitude Q_m corresponding to the optimum value *Wz* goes to saturation with the increase of pressure P_g from 0.7 up to 4.0 Torr. This effect is related to the acceleration of the reverse reactions of H_2O molecules formation with the increase of total pressure in the reactor.

The influence of small N_2 and (N_2 + CO) impurities on the rate of generation of conversion products was also investigated for steady discharge mode. The purpose of these experiments was to check the theoretical assumptions for that increase in the rate of destruction of negatively-charged H_2O products of dissociation (OH^-,H^-) with a small addition of CO. Such process increases the number of electrons used in reactions (1)-(2) and increases the power efficiency coefficient for the H_2O molecules conversion process. In all investigated ranges of plasma parameters, any influence of impurity N_2 or (N_2+CO) on the degree of H_2O molecules dissociation was studied. Unfortunately, experiments on the influence of pure CO, as well as N_2O and NO (as impurities) on the rate of dissociation were unable to be completed, because of the absence of gases of necessary purity. The details of these experiments can be also seen in [5].

The results of numerical calculations of plasma parameters according to the equations system (4)-(9) are shown in Fig. 4-6 for the following discharge conditions: gas pressure P_g = 3 Torr ($n_m = 2.5 \cdot 10^{16}$ cm^{-3}), temperature of discharge tube wall T_0 = 300 K, range of the density of discharge current j = 0.1-50 mA/cm^2.

It was stated that for the low reaction rate constants k_d of negative-ion destruction, the large increase of electron temperature T_e occurs with the increase of the power W_z supplied into the discharge (Fig. 4). Theoretical data shows that significant separation between T_v and T_g can take place (Fig. 5). The largest separation value depends on the power W_z and on the reaction rate constant k_d. Note that for a low rate of negative ion destruction ($k_d = 10^{-8} cm^3 s^{-1}$), there exist regions of plasma parameters where the concentration of negative ions n^- markedly exceeds the concentration of electrons n_e (Fig. 6). The obtaining of these data is necessary for further experimental investigations and theoretical analysis.

DISCUSSIONS

We present some conclusions concerning the choice of discharge modes to achieve the maximum vibrational-translational (VT) system non-equilibrium and to optimize the water conversion process.

The increase of the discharge power by more than a certain value (for given conditions) does not result in a significant difference between vibrational T_v and translational T_g temperatures of the system. Under the further increase of discharge current, the energy supplied into the system sharply increases the temperature of gas T_g due to the fast relaxation VT processes. Naturally, the degree of H_2O molecule conversion should thus decrease due to the increase of efficiency of reverse reactions. This fact was observed experimentally. It means that for the achievement of effective plasma-chemical water conversion, it is necessary to remove the water conversion products from the discharge zone. The rate of the above removal process should be comparable with the rate of production of these water conversion products. One of the possible ways is the use of pulsed current discharge.

Note the good concurrence of theoretical and experimental data concerning the magnitude of discharge currents, for which the plateau on the dependence of conversion products generation rate versus power supply is observed (see Fig. 3). It demonstrates the adequacy of the accepted model of elementary processes in the plasma discharge. The influence of small impurities of electro-negative gases (primarily CO and NO) on the degree of water-molecule dissociation in the discharge requires additional research.

Note also that the total energy efficiency coefficient for water-molecule decomposition is critical to the availability of chain mechanisms of reactions (1)-(2). The presence of H and OH radicals in the system provides the high efficiency of mechanism (i) responsible for the production of useful product. At the same time, the breakage of the circuit in the reaction:

$$H_2O + H_2O^* \rightarrow H + OH + H_2O\,, \qquad (10)$$

for mechanism (i) and the formation of long-lived ion OH' in the reaction

$$H' + H_2O \rightarrow H_2 + OH' \qquad (11)$$

for mechanism (ii) diminishes that part of discharge energy which is used to obtain the useful product. With any of the above mechanisms of water decomposition, the reduction of the length of chain up to the multiplicity $I_0 = I$

results in the decrease of the energy efficiency coefficient (EEC) up to 10-15%. At the same time for I_0 = 10-100 mA, the EEC value can be increased up to 50-60%. The realization of a reasonably long chain of reactions (1)-(2) is also a problem, especially for plasma discharges at high pressures.

The above reasons are obviously responsible for low (12-20%) EEC for water decomposition in glow discharge [7] as well as for the discharge with hollow cathode. The maximum power efficiency for plasma-chemical water conversion therefore is achieved in microwave discharges where it can reach 40% [8].

However, note some difficulties of practical creation of on-board devices for plasma-chemical conversion of water. To achieve the effective operation of such devices, the degree of ionization of plasma should be reasonably high: $n_e / n_m > 10^{-3}$-10^{-4}. Clearly, for electron energies that are insufficient for the effective excitation of H_2O electronic states, i.e. for $T_e \cong$ 1-3 eV, the obtaining of the necessary degree of ionization is not a simple problem. The standard solution of this problem (using the electron beam for the discharge maintenance) is unacceptable in the case of creation of an on-board device for water conversion.

On the other hand, if the limiting stage during the water conversion is reaction (10), then the degree of vibrational-translational non-equilibrium is limited by the relationship:

$$T_v / T_g < \{1 - (D - E_a) / \varepsilon_{vo}\}^{-1}, \quad (12)$$

where D is the energy of H_2O molecules dissociation; E_a is the energy of activation of the reaction $H_2O^* + H \rightarrow H_2 + OH$; and ε_{vo} is the characteristic vibrational quantum of H_2O molecule.
It means that according to (12), the further growth of energy supply W_z does not result in the increase of H_2O dissociation products in the system.

The requirement of increase the degree of ionization results in the reduction of plasma pressure and in the suppression of the processes of negative ion formation in the volume. In turn, it results in the reduction of the power efficiency of water molecule decomposition processes due to the increasing specific power and to the consumption of supplied energy into unproductive channels; for example, into the excitation of electronic states of H_2O molecules. The solution to this problem again is the increase of supplied power simultaneously with a sharp increase in the speed of removing useful products from the active zone of the discharge.

CONCLUSIONS

The mechanisms of dissociation of water molecules for steady-state water vapor discharge at low pressure have been investigated. The influence of vibrational excitation of H_2O molecules on the ionization-recombination kinetics of the discharge was determined, the rate of generation of conversion products and the degree of vibrational non-equilibrium of the system were evaluated as a function of the energy supplied into the discharge.

Under the density of discharge currents j = (8-10) mA/cm^2 for pressure P_g = 1-3 Torr, the rate of generation of the products of H_2O dissociation reaches saturation. The degree of conversion of initial water molecules is 10-15% and is not increased with the further growth of the discharge current. This is a function of the increase of gas temperature T_g and with the increase of reverse reactions efficiency.

The pressure increase in the system and the transition from glow discharge to other types of high-voltage discharge are necessary for the increase of ($H_2 + O_2$) output. This should be accompanied by an increased pumping rate of the initial mixture through the reaction zone. Due to the high rate of VT relaxation, the increase of water-conversion efficiency, due to the increase of the power supplied to the discharge, can be achieved only by the quenching of the conversion products and by fast removal of conversion products from the discharge zone.

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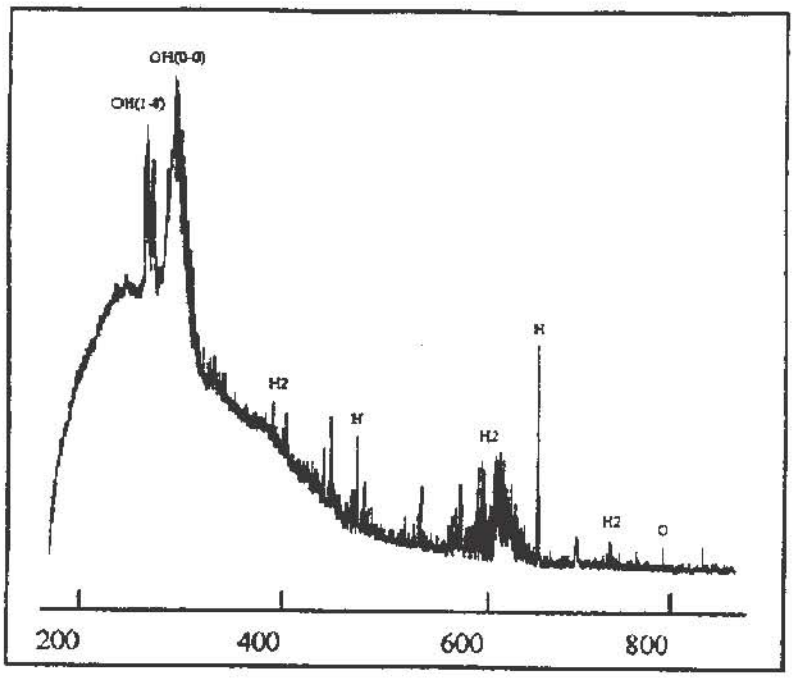


Fig.2. Radiation spectrum of water vapor for total pressure Pg = 1.5 Torr and discharge current I = 25 mA.

X- wave length, nm; Y- intensity of spectral lines.

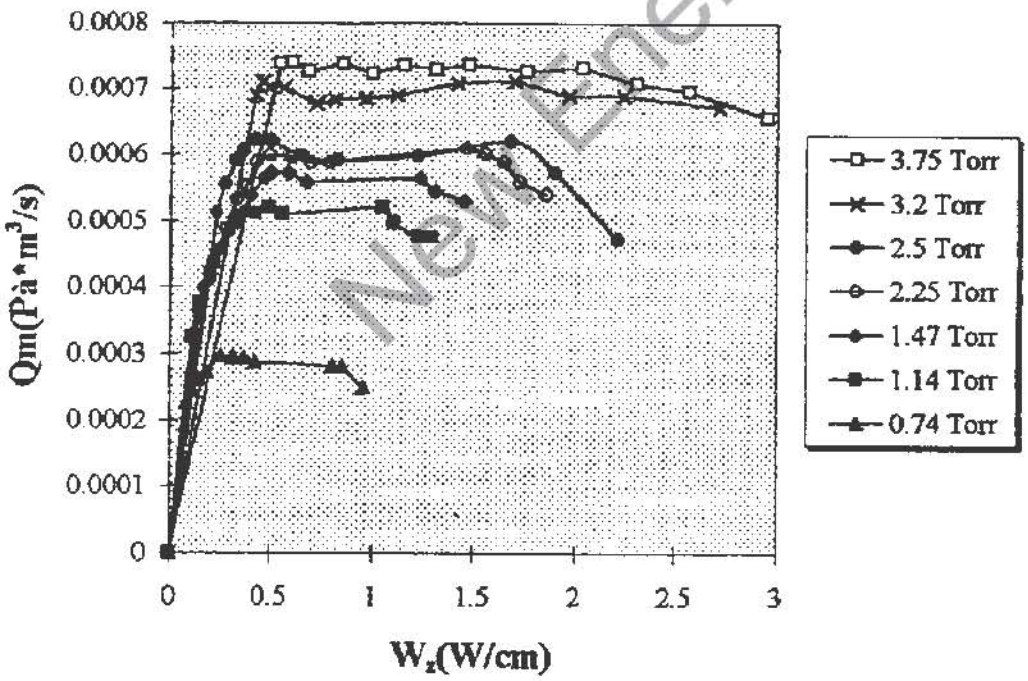
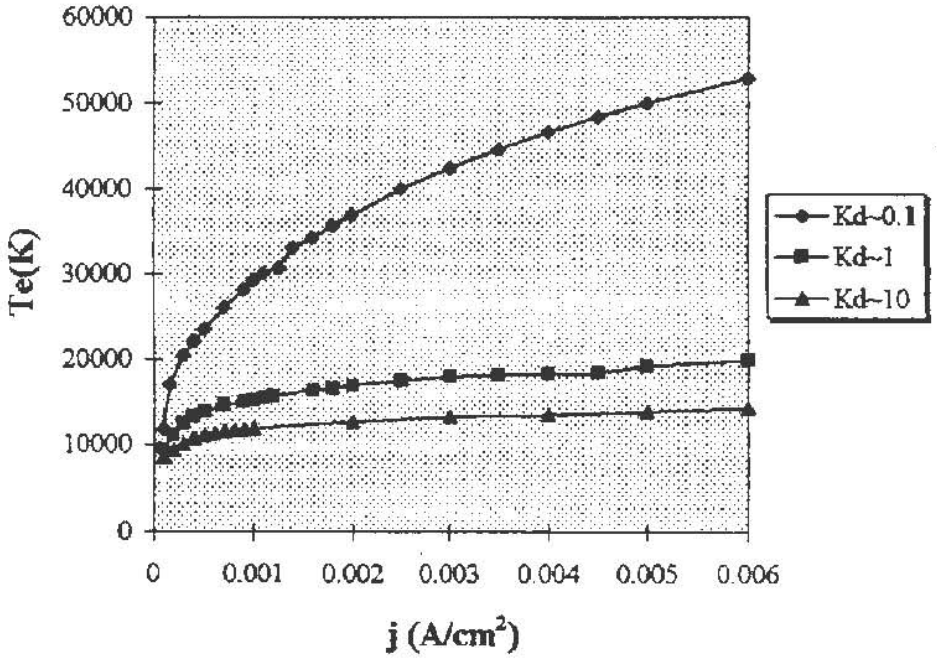


Fig.3. Flux of gaseous products of water dissociation from the reactor zone.

X- specific power supply (W/cm) ; Y- Q_m(Pa.m^3/c).



ig.4. Electron temperature T_e versus discharge current density j.

X- density of discharge current j(A/cm^2); Y- T_e(K).

(K_d = 1 corresponds 10^{-7} cm^{3}s^{-1})

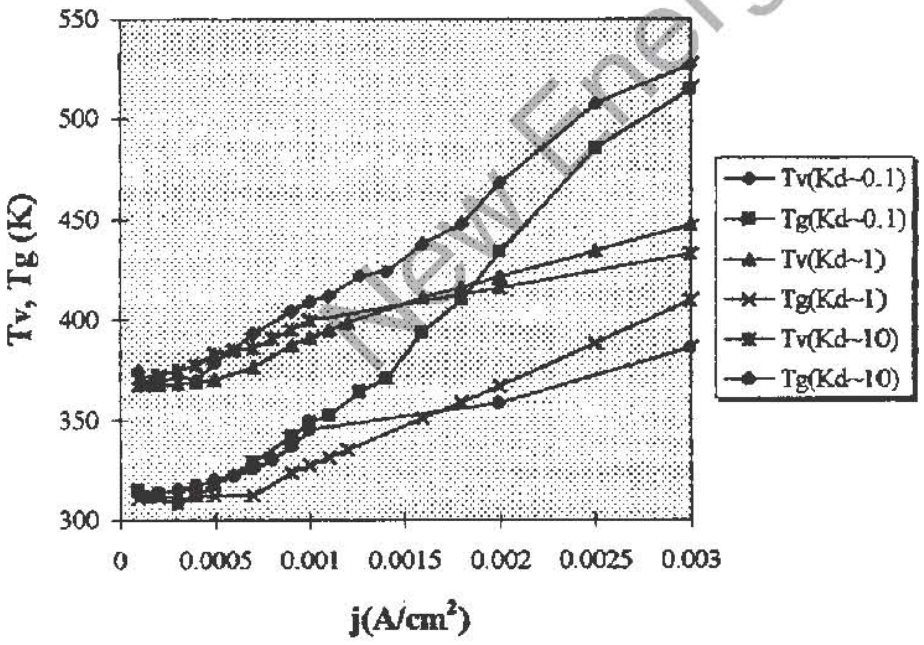


Fig.5. Vibrational T_v and gas T_g temperatures of molecular component versus discharge current density j.

X- density of discharge current j(A/cm^2); Y- T_v, T_g (K).

(K_d = 1 corresponds 10^{-7} cm^{3}s^{-1})

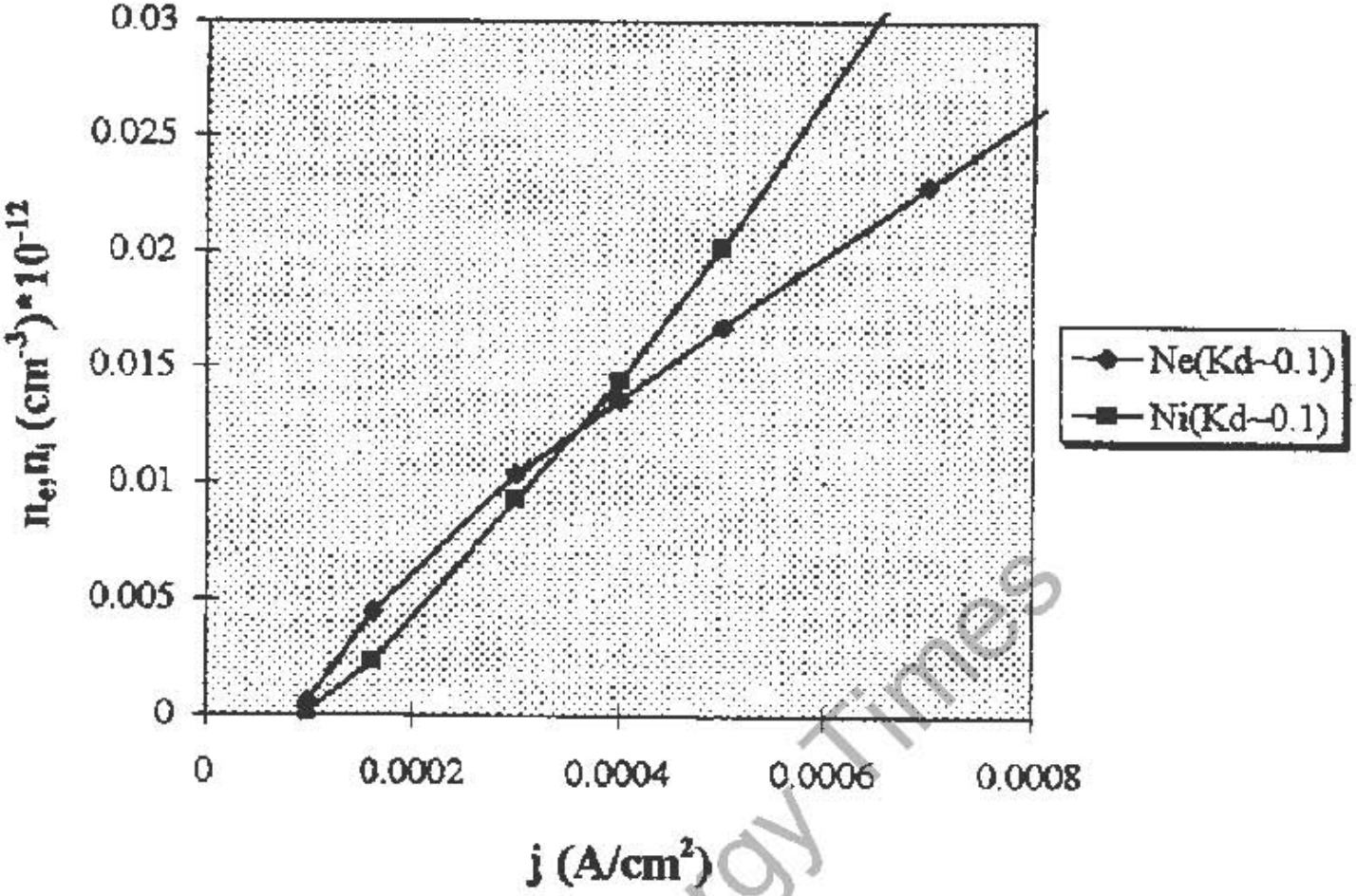


Fig.6. Concentrations of electrons n_e and of negative ions n_i versus discharge current density j.

X- density of discharge current j(A/cm^2);
Y- $n_e, n_i\ (cm^{-3})10^{-12}$.

(K_d = 1 corresponds 10^{-7} cm^{3}s^{-1})

THE REDISCOVERY OF COLD NUCLEAR REACTIONS

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INTRODUCTION

The word transmutation is often associated with medieval alchemy. Nevertheless, the change of one element into another is a common place of modern nuclear chemistry carried out in nuclear reactors or in high energy cyclotrons.

In the last few years a number of pieces of information have arisen which suggest that there is a low temperature way of provoking nuclear changes. There are several titles at present being used to describe the reported phenomena. They are: chemically stimulated nuclear change; lattice assisted nuclear change; low temperature nuclear change; cold nuclear reactions. This latter term will be used in this article. Such reactions embrace also the D + D reactions discussed since 1989, in the so-called cold fusion literature, but include a wider swathe of systems, characterized by observation of changes in solid systems, not far (e.g., up to 1000°K) from room temperature which seem only explicable on the assumption that a nuclear change has occurred although none such would be expected based on the current theories of nuclear chemistry.

EARLY SUGGESTIONS

Amaldi, Fermi and Rasetti [1] were the first to carry out a cold nuclear reaction. They applied 200 kV across an ice crystal kept at the temperature of liquid air but in a deuterium atmosphere. Neutrons were produced and the authors suggested that the electric current caused the cold nuclear reaction D+D $\rightarrow He^3+n$ to occur. Borghi [1] inferred the occurrence of cold nuclear reactions when he observed neutrons as a result of applying 5000 volts in a Klystron containing D_2.

Kevran [2] wrote much about the presence of cold nuclear reactions in biological and geological systems.

1992 AT TEXAS A&M UNIVERSITY

In April 1992, a suggestion was made to Bockris by J. Champion[1] that explosive heating of a mixture of cheap materials including mercurous chloride and lead chloride would form noble metals. Experiments to examine Champion's method were carried out in the Chemistry Department at Texas A&M University by Bockris and two senior research scientists, G.H. Lin and R. Bhardwaj. ß activity in the residue obtained after heating was observed and decayed as if it originated from Pt^{197}[3]. On four consecutive experiments variable amounts of noble metals were observed as a product of the heating [4]. The analyses were always carried out by at least two independent analytical methods and in two experiments by up to four different analytical organizations (which often gave results

[1] Champion reported that the basic idea and technique had been originally described to him by J. Keller who had worked in the 70's with R. Becker and Y. Lusitch.

only in qualitative agreement). Later (December 1992), the people who had carried out the initial experiments could not reproduce the same results.

In all experiments, gold (100-1000 ppm) was the main product but traces of Rh, Pd, and Pt were also seen.

In December 1992 there were reports about the results of some experiments performed in the Cyclotron Institute at Texas A&M, The work came from the authorship of Kevin Wolf [5] who was being supported on an EPRI contract to study the phenomenon widely referred to as Cold Fusion. Wolf found that three of the Pd electrodes which he had been using to examine neutron production and to try to see if tritium was also formed (as he had earlier reported), became "hot" after being saturated with D and upon analysis, some of which were carried out by T. Claytor [6], it was found that the palladium contained numerous radioactive nuclei which were identified by examination of the x-ray spectrum. The estimated concentration was in the region of 10^9 atoms per cc for each species.

Work in the Chemistry Department on transmutation in 1993-94 was furthered by Sundaresan and Bockris [7] who carried out experiments using spectroscopically pure carbon rods to form an arc in highly purified water. Great precautions were taken about contamination. It was found (Table I, below) that if oxygen was present, iron was formed in amounts about 100 times more than would be expected from contamination or from the residual impurities in the Johnson Matthey spectroscopically pure C. If oxygen was not present, no iron was formed. The similar experiments were reported by other scientists [8-9]. However, isotopic abundance of the "new iron" was not measured by Sundaresan. Similar results have been reported by others who could detect no difference in the isotope ratio in the "new" Fe.

Table I

	Electrode 1			Electrode 2			Electrode 3		
Time (hr)	Wt. of carbon (mg)	iron (µg)	iron in carbon (ppm)	Wt. of carbon (mg)	iron (µg)	iron in carbon (ppm)	Wt. of carbon (mg)	iron (µg)	iron in carbon (ppm)
1	24.5	3.43	140	30.3	1.4	46.2	25.1	1.94	77.3
3	79.1	9.62	121.6	83.6	22.8	272.7	86.3	15.0	173.8
5	140.9	1.1	8	142.7	4.5	4.5	-	-	-
10	-	-	-	-	-	-	286.1	39.9	139.5

THE REIFENSCHWEILER EXPERIMENT AND NUCLEAR WASTE DISPOSAL

Reifenschweiler published a paper in 1993 in *Physics Letters A*, in which he reported that, in 1967, he had been examining some tritium sensors [10]. Adventitiously, he had heated them and found the tritium radioactivity was substantially reduced. He had taken precautions to be sure that the tritium containing compound had not evaporated or decomposed and concluded, therefore, that heating the tritium compound had caused the decrease in radioactivity.

The results of this experiment, with its prestigious background (it was done in the Phillips Lab in Eindhoven) seemed similar to those of Yul Brown, carried out between 1993 and 1995. A description of a demonstration of Yul Brown's experiment was published by Dan Haley [11]. Several DOE engineers were present but refused to report that they had observed the cessation of the radioactivity after Brown had heated a mixture containing such wastes with the so-called Brown's gas (essentially hydrogen-oxygen flame) and shown a 95% decrease of radioactivity. The DOE inspectors suggested that the apparent cessation was due to sublimation of the material into the laboratory. However, inspectors from the California Department of Health found no radioactivity. The DOE engineers then suggested that the disappearance of the radioactivity must be due to screening due to new particle formation. Powdering the post-experiment particles was also negative. The engineers refused to report that they had witnessed a reduction of radioactivity because it was anomalous within their knowledge.

An independent partial verification of Yul Brown's transmutation was carried out by Chinese Baotou Nuclear Institute [12]. The substance investigated was ^{60}Co. Its radiation was reduced by about 66% on heating for a few minutes in a hydrogen-oxygen flame. In other experiments, a 99% reduction in radiation (e.g., of americium) has been obtained.

Jack Keller demonstrated the reduction of radioactivity in a 1995 experiment in New Orleans, using the explosion method which had been used by Champion in his radioactivity experiments at Texas A&M. The experiment gave rise to a 50% reduction of radioactivity [13].

R.A. Monti, working with E. Bauer in Vancouver, has published [14] a description of his own investigation of the results of heating the ThO_2. One of the diagrams from his paper is reproduced here (Fig. 1).

Monti reports the presence of a number of new materials in the residue [large quantities (~1000 ppm) Pb, Al, Mg, Ce and Fe] including 5 ppm of gold.

Some work was carried out on similar residues by Noninski [15,16] and he made two negative reports on his experiments, the aim of which was to detect whether the residues contained gold. His neutron activation experiments may have lacked the sensitivity to detect 5 ppm.

More recently, a group at the University of Cincinnati under Gleason has been experimenting on the decrease of the activity of nuclear waste on electrochemical processing (patent applied for) and they report having found a number of new nuclei in the resulting deposit [17].

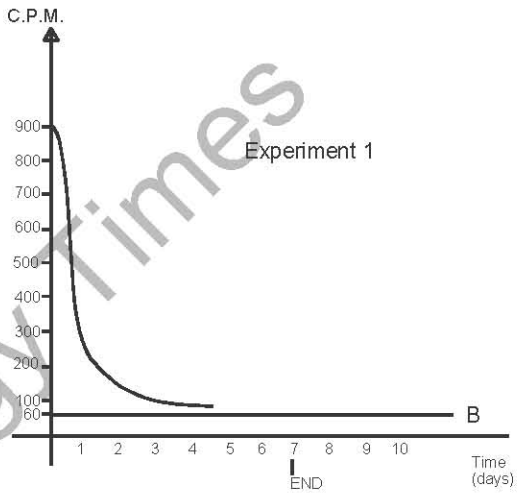

Fig. 1 Radioactive decay in Monti's experiment [14

JUNE 19, 1995 MEETING AT TEXAS A&M

These numerous reports, particularly the work at Texas A&M in 1992, but also a number of corresponding reports from the United States (Bush) and Japan (Mizuno, Notoya, Ohmori) all encouraged us to hold a meeting to discuss these phenomena which are anomalous within accepted normal nuclear chemical experience. The proceedings of the meeting at Texas A&M have been published in the first issue of the *Journal of New Energy*, and therefore here they will be summarized only briefly.

1. Tom Passell [5] who knew of the 1992 unpublished Wolf work through contact with Tom Schneider, his colleague at EPRI and Wolf's Manager, gave a description of the work based upon the reports that Wolf had made to his sponsor, EPRI. The electrodes which Wolf had exposed to D_2 until the Pd was saturated with D contained around 10^9 atoms of Ag, Pd, Rh, respectively, and also some isotopes of Pd which had a ratio different from those of natural palladium. Wolf's observations (some materials were radioactive) seemed to prove transmutation. On the other hand, Wolf reports he could not reproduce the results, his basis for the absence of publication.[2]

2. T. Ohmori (University of Hokkaido) reported that utilizing gold and palladium cathodes, he had found the formation of iron on the electrode surface during hydrogen evolution [20]. He had analyzed the iron isotopes and found that the Fe^{57}/Fe^{54} was much greater than the natural ratio. Ohmori's work brings out the extreme ease of achieving nuclear reactions: transmutation products turn up upon electrolyzing light water, a result earlier implied by Matsumoto. [21]

[2] It has been reported [18] that Wolf himself favors the action of a large but unknown particle which occasionally arrives from space and strikes his electrodes. Hoffman [19] suggested that the D_2O source used by Wolf could have contained the radioactive isotopes which were found in Wolf's electrodes.

3. John Dash [22] from Portland State University reported experiments which were similar to those of Ohmori. He simply utilized platinum and palladium electrodes in an aqueous sulfuric acid solution. Analysis by SEM on the cathodes determined that silver and cadmium were present in spots upon the surface. Large concentrations of gold were found in dendrites protruding from the palladium, both in light and heavy water. When the current was switched off, the changes continued. Chromium, iron and calcium were found on a titanium electrode in similar experiments. These experiments also resonate with the statements of Rabzi at the June 19 meeting that high electric field transfer lead to transmutations.

4. Kucherov [23], reporting experiments carried out in 1992 in Moscow with colleagues Karabut and Savvatimova, described glow discharge plasma experiments with one milliampere of current and voltages of about 100 V gave rise to a number of new elements in the palladium. In the presentation at Texas A&M, Kucherov was extremely cautious about impurities as a source of these but thought that with some of the new nuclei he and his colleagues had detected there seemed to be no origin for them except low temperature nuclear changes involving D and Pd.

5. Robert Bush pushed experiments of this type further, finding that he could observe strontium formed as a product from rubidium in electrolysis. Bush measured the isotopic ratio of the strontium finding that it was radically different from the natural ratio. [24]

6. Notoya also from the University of Hokkaido reported calcium formed from potassium; cesium produced barium [25]. On the other hand, Notoya uses an open cell and isotopic ratios have not been measured.

7. G. Rabzi from the Ukrainian Academy of Science, presented several results which he said were transmutational [26]. As an example 99.5% lead was treated (essentially by heating) and yielded a number of developments including 0.2% of gold. He claimed, similar results to those of (separately, Yul Brown, Monti, Keller and Gleason), that radioactive wastes could be "stabilized" by simply heating the material.

8. One of the most interesting papers published at the Texas A&M meeting, was that by Y. Kim [27]. He had been able to make a formulation of the theory of barrier penetration showing that when energies were low, the transparency of the Coulomb barrier greatly increased. One of the results of Kim's work was to show the probability of proton capture by higher mass elements was about 50 orders of magnitude larger than the proton capture probability by lighter mass elements.

9. Peter Hagelstein [28] presented an alternative view of how cold nuclear reactions occur. He suggests neutron hopping can transfer energy. Resonant emission and neutron capture by another nucleus may explain some of the observed results. He has pointed out the direct relevance of his work to an interpretation of the nucleus A to nucleus B results now widely reported.

10. One of the more remarkable experiments was reported by T. Mizuno who used an alternating current field produced between 5 and 45 volts applied to a ceramic at about 500°C [29]. This not only produced heat above that arising from the electric current but also new materials including Al, Bi, Sn, Gd, Dy are produced. Mizuno found these new nuclei have isotopic abundance ratios radically different from normal ones,

11. Lastly, R. Monti gave a presentation [14] of the work concerning the decay of the radioactivity of ThO_2 mentioned above.

WORK ON THE CETI CELLS

Particular attention has been given recently in recent discussions to the work of George Miley because of the background and experience of this worker in his function as a nuclear physicist and editor of the *Journal of Fusion Technology*.

Miley has been carrying out work to examine and confirm the measurements made by the Clean Energy Technology (CETI) organization on excess heat produced in cells containing palladium-nickel beads. Miley and his coworkers have detected a number of new materials within the palladium in results which bear same resemblance to those of Wolf and of Kucherov [30].

DAMAGE FOUND IN PALLADIUM-HYDROGEN CELLS

Work has been published by Matsumoto [21] in Japan upon what he calls "black holes." These are the small holes and fissures found in electrodes which have been used to evolve hydrogen. According to Matsumoto the holes are due to micro fissures occasioned by heat due to local nuclear reaction.[3]

Some support may be given to this view by the work of R. George and J. Stringham [31]. They have found in sono-illumination of palladium, that new nuclei are formed within the palladium but that these nuclei form at points of damage. Correspondingly, Nate Hoffman who, in analyzing electrodes from the original Texas A&M work on helium production, found that the helium was largely found in fissures within the palladium.

This raises the possibility that works, such as those carried out recently by Minevski at Texas A&M on damage in Pd electrodes saturated with D or H, may be subject to a nuclear interpretation [32]. Thus, Minevski found extensive damage and hole formation within his palladium electrodes only at a depth of a few microns. He also found a number of new nuclei at a similar depth but not at the surface, in regions in which is much Li^4.[4]

CONCLUSIONS

There is now extensive evidence that nuclear reactions occur slowly in the cold within solid lattices in the presence of H or D. There is weak evidence that nuclear reactions may occur in some biological systems. These findings should give rise to revision of the theory of nuclear kinetics in the solid state [2, 32-34]. The findings have the potential of giving rise to a revolution in the treatment of nuclear wastes. They greatly extend the possibilities of chemically assisted nuclear reactions as energy sources.

Thus, the discoveries have bearing on the mechanism of the heat formation in experiments named (misleadingly) "cold fusion." Thus, the measurement of helium in the output stream by Miles and Bush [36] at China Lake has given rise to the thought that the reaction causing the heat in cold fusion is $D + D \rightarrow He^4 + \gamma$ but the Miles measurements indicate an amount of He^4 only enough for 50% of the heat. There is unexplained heat left over and it may be that reactions providing transmutational debris inside the palladium provides the missing heat. The palladium in the electrodes is being "burned up" by the protons and deuterons within the lattice (the fission products found being the results of "cold nuclear combustion").

Available nuclear energy without dangerous waste production is the essential practical attraction of this work. It seems that it may be applicable to the treatment of wastes produced by fission reactors at a fraction of the time and cost of present methods. Cheap tritium also may become available.

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COLD FUSION AND THE COULOMB BARRIER

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ABSTRACT

The current atomic model considers the atomic nucleus of an atom to be made of a combination of protons and neutrons with these particles being held together by **the strong nuclear force**. The positively charged nucleus represents a barrier (the Coulomb barrier) to a positively-charged proton so that fusion is unlikely, especially between protons and elements with high atomic numbers such as palladium. Replicated experimental facts show that many nuclear reactions take place in typical cold fusion electrochemical cells. The foremost problem in understanding cold fusion is to determine the mechanism by which protons or deuterons appear to penetrate the Coulomb barrier. The explanation requires a change to the current scientific model of the atomic nucleus and permitted nuclear reactions. The newly-published **Rowe Effect** is suggested as a possible mechanism for bypassing the Coulomb barrier.

INTRODUCTION

The typical Pons-Fleischmann electrochemical cell consists of a lithium-containing, heavy-water electrolyte using a platinum anode, and a palladium cathode. Fusion events are believed to occur on or within the surface of the palladium cathode involving the hydrogen ions (deuterons and/or protons) produced by electrolysis.

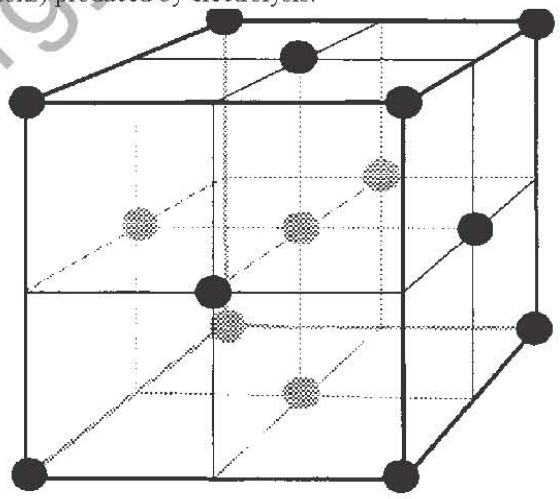

Fig. 1. Face-Centered Cubic Crystal

Palladium is a metal known for its ability to absorb hydrogen. Palladium is a crystalline material with the crystals being **face-centered cubic** crystals as depicted in Fig. 1. The palladium atoms are shown (by X-ray studies) to be positioned at the vertices of a cube with additional palladium atoms in the center of each side and in the interior of the cube. The 46 electrons that are associated with each atom of palladium constitute four major **spherical shells** that surround each atom with ten electrons in the 4d outer shell. To simplify the mathematics the electrical charge of these 46 electrons is considered to be smeared over the entire crystal volume. However, the combination of electrons around each palladium atom in the metal lattice (crystal) provides sites which can be occupied by hydrogen ions (protons or deuterons). As the water in the electrolyte is electrolyzed, hydrogen ions are produced on the surface of the cathode and either form gas bubbles or enter into the palladium lattice. The diffusion of the hydrogen into the palladium is accomplished by a hydrogen ion occupying a site within the palladium lattice and then **hopping** to another site as diffusion continues. Note that the hydrogen ion occupies a site for a much longer time period than it takes to **hop** to another site. [1]

Cold fusion experimental evidence indicates that there are few nuclear reactions until a certain degree of "loading" is achieved. This degree of loading is expressed as a ratio of hydrogen ions to palladium atoms and few nuclear reactions in a heavy-water cell occur before that ratio is 0.85 or larger. The higher the ratio, the more active the heat-producing processes.

In addition to the electrons associated with the palladium atoms, the cathode is a conductor for millions of electrons that flow from the power supply through the palladium cathode, into the electrolyte and into the anode. With this

combination of electrochemistry, excess heat is often produced. It is believed that this excess heat comes from the results of nuclear reactions taking place on the surface of or within the palladium metal lattice.

The latest experimental evidence shows that a typical cold fusion cell (with either heavy water and palladium or with light water and nickel) produces a large variety of nuclear reactions. Initially, it was suggested that the major nuclear reaction was deuterium + deuterium in a heavy-water cell. Later, it was suggested that the hydrogen reacts with the lithium (or other alkali element) in the electrolyte. While these nuclear reactions appear to occur, the surprising findings are that many other nuclear reactions are also occurring. For example, Bockris, et al. [2], and Mizuno, et al. [3], both show that many new elements (not present in the cell at the beginning of the experiment) are produced.

CONCEPTUAL ULTRA-MICROSCOPE VIEW OF THE ATOMIC NUCLEUS

If we accept the current atom model, at the scale of the atomic nucleus, we would have a view as depicted in Fig. 2. Here is shown a single palladium nuclei with a nearby hydrogen ion (proton or deuteron). Assume that you try to move the hydrogen ion toward the palladium nucleus. The atomic model considers that there is a **strong nuclear force** (stronger than Coulomb force at distances up to about 4 femtometers) that holds all of the similarly charged protons together with the 56 to 64 neutrons that make up the various palladium isotopes. This force is described as having limited range but is considerably stronger than the repulsive force of the positively charged protons. Farther away from the nucleus the electrical charge predominates. In plasma physics, the energy that must be given to another positively charged particle (ion) to enable that particle to surmount the Coulomb barrier is well studied and well documented. Charts are available for many different elements that show the energy necessary for an ion to penetrate this barrier in a plasma.

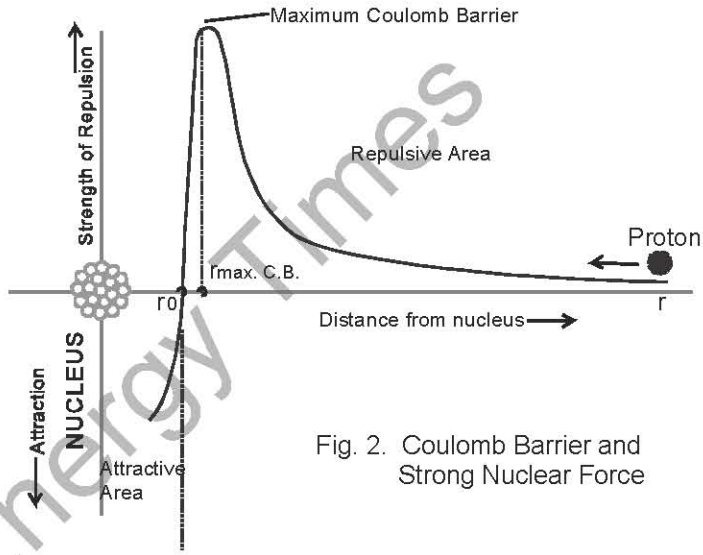

Fig. 2. Coulomb Barrier and Strong Nuclear Force

Conditions within a crystal lattice are vastly different than for hot plasmas, and **yet we try to adopt high-temperature gas physics measurements to a metal lattice -- without great success**. It is generally agreed, among cold fusion scientists, **and strongly rejected by many other nuclear scientists**, that protons (deuterons) do penetrate the Coulomb barrier. See references [2] & [3] for compelling experimental evidence. How this penetration is accomplished is the major difficulty in explaining low-energy nuclear reactions in electrolytic cells for either the heavy-water/palladium or the light-water/nickel cold fusion cells. **The highly replicated cold fusion experiments show a large number of anomalous nuclear changes resulting in the formation of new elements (elements not present in the cold fusion cell at the beginning of the experiment. These elements appear to be of atomic numbers ranging from 20 to 28, 46 to 54, and 72 to 82 [3] and are found in the palladium cathodes at a depth of about one micron [2].** Expert electrochemists state that it is not possible for these elements to diffuse from the surface of the cathode to a depth of one micron during the time consumed in the electrochemical experiment.

PENETRATING THE COULOMB BARRIER

If the science of nuclear physics included a method of how the Coulomb barrier could easily be surmounted, cold fusion would have been a more acceptable discovery. **Surmounting (or bypassing) the Coulomb barrier is the most compelling theoretical problem involved with cold fusion.** The next step, in this discussion, is to explore possible alternative explanations (models) of how the Coulomb barrier may be surmounted.

Among the more than 25 cold fusion theories, here are some alternative hypotheses that this author believes are most probable:

1. Wavicle resonance. The penetrating proton (deuteron) can be treated as a wavicle (contrasted with particle) having a characteristic de Broglie wave length. Such a wavicle is deemed to be involved in a resonance condition with a periodic array of metallic elements in a crystal lattice. The end result is a type of **proton (deuteron) capture** by a larger element of higher atomic mass. This **proton capture** can explain nuclear reactions within a metal lattice or with an alkali element from the electrolyte (such as lithium). Resonance is favored by Dr. Robert Bass [4] as an explanation of d + d nuclear reactions in a palladium lattice. Bass also shows that a nickel lattice can become "transparent" to a proton.

2. Neutron fusion. It is suggested that protons can combine with electrons in the metal lattice to produce neutrons. These neutral particles can then penetrate the Coulomb barrier. The problem is to explain how neutrons are easily produced and if they are why neutrons are so little observed in cold fusion experiments. Peter Hagelstein [5] of MIT is currently evaluating this model.

3. Pressure-induced fusion. When an electric potential helps to accelerate the diffusion of hydrogen isotopes into a palladium lattice, the effect can be compared to what the same effect would be if the hydrogen were placed under pressure. Some authors [3] cite this **artificial pressure** as being as high as 10^8 atmospheres (15 million pounds per square inch). With this high pseudo-pressure, it is hypothesized that several deuterons could be forced into fusion with a single palladium atom. Mizuno, et al. [3] use this hypothesis to list several **palladium plus 8 deuterons** nuclear reactions to produce xenon (which was produced in anomalously large amounts in the experimental work of these authors).

4. The Junction Model. Dr. Xian Jin, a scientist from China, has proposed a model that includes the production of anomalous high voltages near a boundary of two dissimilar metals (such as Nickel and Palladium) [6]. These voltages are produced by the contact potential that is the result of the boundary between two dissimilar metals **plus the electric field effect caused when hydrogen ions also occupy this boundary region.** The experimental results of Yamaguchi [7] may best be explained by this model where a palladium plate is plated with gold on one side and manganese oxide on the other. With the application of a voltage a burst of neutrons are produced and extensive heat buckles the palladium.

5. Bypassing the Coulomb barrier. This explanation is based on Paul Rowe's hypothesis [Rowe Effect] that the aether is a precursor for the production of proton/electron pairs, and that, provided with sufficient energy, hydrogen is produced [8]. Based on Rowe's experimental evidence, this author suggests that a nuclear reaction in a metal lattice is a sufficiently energetic occurrence to produce one or more protons [9]. It is further hypothesized that such proton production is more likely to occur near the atomic nucleus. **In this fashion, protons can be produced within the Coulomb barrier.** If the reaction is sufficiently and locally energetic (exothermic), then more than one proton could be produced within the Coulomb barrier near a massive nuclei. This concept explains two experimental observations: the anomalous production of nuclear reactions that are best explained by the penetration of the Coulomb barrier and the experimental evidence of multi-body nuclear reactions. **However, to accept this hypothesis one has to accept the existence of an energetic aether.** Although over 400 peer-reviewed papers discuss the existence of the aether (zero-point energy) [10], many scientists do not, as yet, accept the evidence and will, therefore, reject this hypothesis.

SUMMARY

This paper has presented a brief review of the current model of the atomic nucleus and the difficulty of using that model to explain the anomalies discovered in the study of cold nuclear fusion. The biggest conceptual barrier to the understanding of the cold fusion experimental results is the penetration of the **Coulomb barrier**. Several hypotheses are reviewed that attempt to explain the experimental evidence of numerous low-energy nuclear reactions. Evoking an author's privilege to select a favorite hypothesis, it is suggested that the Coulomb barrier is not being penetrated, but is being bypassed by the aetheric production of proton-electron pairs **within the Coulomb barrier.** The author is devising experiments by which this hypothesis can be tested.

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TORSIONAL FIELDS AND ELECTROCHEMICAL PROCESSES AT METAL-ELECTROLYTE INTERFACE

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ABSTRACT

A concept about the effect of a torsional field on the electrochemical (involving charge transfer) reactions of spin-polarized particles is advanced. Effects are found when examining hydrogen permeability of palladium membranes in the system Pd/0.5 M H_2SO_4, Pd/0.1 M NaOH and also in the investigation of the electrode potential changes in the system Cu/x M $CuSO_4$ + 0.5 M H_2SO_4 (x = 0.01 and 1.0). A hypothesis is put forward that torsional fields alter the potential of interaction in the electrochemical systems in question, and can affect both the crystal's phonon spectrum and spin orientation of reacting particles.

INTRODUCTION

The presence of a number of fundamental difficulties in the general theory of relativity (GTR) and also the need for construction of a microscopic unified model of all physical interactions has induced one to seek for solutions outside the scope of standard GTR. The theory of gravitation with torsion (torsional field) is the nearest generalization of GTR [1,2]. Analysis of works on the gravitation theory with torsion and analysis of physical effects in torsional fields is the subject of a number of reviews [3-5]. The simplest model in the theory of gravitation with torsion is the Einstein-Cartan theory. This theory takes into account spin particles of matter and describes their effect on the geometrical structure of space-time, which is characterized by non-trivial curvature and torsion [1]. The Einstein-Cartan theory (ECT) has two principal features:

1. Torsional equations are the algebraic relation of torsion to its source - spin of the particles of gravitating substance. According to the ECT, torsion does not propagate.

2. Since a unified Lagrangian with a unified relation constant (Einstein-Newton gravitational constant G) is used to obtain gravitation and torsional fields, spin-torsional interaction is proportional to G and very weak because the smallness of gravitational constant G is "aggravated" by the small value of Planck constant h, with the help of which magnitude of spin of a gravitation source is usually characterized in the classical (non-quantum) version of the theory.

CONCEPTS

General dissatisfaction with the limited potentialities of torsion in ECT has lead to the appearance [6] of versions of torsional theories in which torsion (torsional field) can propagate in vacuum and is, far from always, associated with the substance's spin. These theories were no longer purely gravitational theories: up to a dozen of torsional relation constants were included in the Lagrangians in addition to the Newton constant. The appearance of new torsional theories, different from ECT, has brought into existence the problem of the determination of the constant of torsion's relation to its source, which could be resolved only through experiment. Note also, that modern multidimensional physical theories use elementary particle models constructed on the basis of torsional field.

Although being weak, a torsional field, acting on particles' spin torsional field, may be used to control a flow of particles with spin.

Experimental works, indicating the linkage between electromagnetic phenomena and torsional field, are known [6,7]. Results of these works are difficult to account for without invoking the concept of torsional field. At the same time, a number of devices (torsion generators) have been suggested, which generate the field (not an electromagnetic one) that appears to be a torsional field. Theoretical and experimental study of the torsional field generation by electromagnetic systems and also investigation of the effect of torsional generators on different physical-chemical processes, including electrolysis and the processes of cold nuclear fusion involved in electrolysis of heavy water, has now become a topic of interest [8].

It seems likely that experimental detection of the impact of a torsional field on electrochemical systems should be carried out on the objects which are influenced substantially by the configurational factor $A=ve^{\Delta S/k_B}$ in the kinetic equation

$$i = A \cdot e^{-E_a/k_b T}, \quad (1)$$

where E_a is the standard free activation energy, v is the vibration frequency of the reacting particle, ΔS is entropy change, k_B is Boltzmann constant, T is absolute temperature.

Influence of torsional field can lead to the formation of structures with lower entropy at the metal-electrolyte interface. From the preliminary considerations, it follows that a reaction of charged particles would be more dependent on the impact of torsional field if the particles are forced to maintain their orientation position unchanged in space over a short period of time.

DISCUSSION ABOUT THE CONCEPT AND EXPERIMENT

Measurements were conducted using an experimental setup incorporating electrochemical block and torsional field generator. Variations of the electrochemical block contained either a cell for measuring hydrogen permeability of membranes or a cell for measuring electrode potentials.

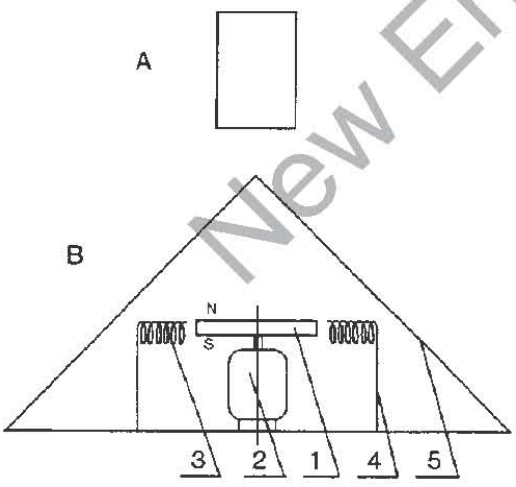

Fig. 1. Schematic diagram of the experimental arrangement.
A - cell for measuring hydrogen permeability or electrode potentials
B - torsional generator with permanent magnet (1), rotational electric drive (2), solenoid (3), connecting strip (4), and casing (5).

Magneto-mechanical generator (type I) along with electromagnetic torsional field generator (type II) designed by Centre of Intersectoral Science, Engineering and Venture of Non-Conventional Technologies (Moscow, Russia) and magneto-electric generator (type III) of the Scientific and Industrial Centre "Arsenal" (Perm, Russia) were used in the experiment.

Magneto-mechanical version of the torsion generator consists of a flat permanent carbide-cobalt magnet with the vertically oriented N-S polarity. The magnet is rotated about the axis by means of the electric drive. In the area of the permanent magnet position, perpendicular to the N-S magnetic axis, solenoids, generating transverse alternating magnetic field, are mounted. The system is placed under a cone-shaped casing, made of insulating material, which is screened by metal foil and grounded.

The objects to be investigated, were placed 50 mm above the cone's top, along the N-S magnetic axis. The magneto-electric torsion generator was a composition of excitation winding and permanent magnets.

1. Measurements of electrode potentials. Potentials of electrodes of the first kind (Cu^{2+}/Cu) and redox electrodes (Fe^{3+}, Fe^{2+}/ Pt, quinhydrone electrode) were measured. Measurements of electrode potentials were carried out in a variety of ways: changing the positions of the measuring device (digital voltmeter) and the reference electrode

with respect to the torsional field generator. In some experiments, an electrochemical cell was placed in a metallic grounded screen.

For the copper electrode in solutions x M $CuSO_4$ + 0.5 M H_2SO_4 the results were qualitatively reproducible (Fig. 2). After switching on the generator with the axis directed towards the electrode under study, the potential would shift first to more negative values (by a maximum of 0.35 mV when x = 1 mol/l), then a shift in opposite direction would commence, the positive ΔE usually being larger in magnitude than the negative one. At x = 1 mol/l, minimum potential was achieved some 5 minutes after turning on the generator. A hundredfold decrease in copper sulphate concentration (x = 0.01 mol/l) did not change the behavior of the potential but the values of ΔE were substantially smaller and changes took place more rapidly. When a generator of the type III was used, the potential change of the system Cu/1 M $CuSO_4$ + 0.5 M H_2SO_4 comprised an appreciable magnitude (about 0.3 mV) even for the cell placed in the metallic screen (Fig. 2, curve 3).

In the case of the redox electrodes, changes of E were insignificant (<0.05 mV).

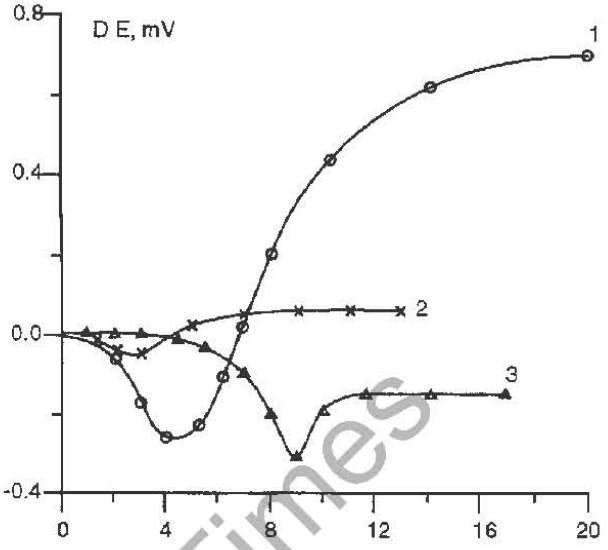

Fig. 2. Typical potential vs. time curves obtained for the systems Cu / x$CuSO_4$ + 0.5 M H_2SO_4 with a magnetomechanical generator (curves 1,2) or with magnetoelectrical generator (curve 3); x = 1.0 for curves 1,3 and x = 0.01 for curve 2.
ΔE is the deviation of electrode potential from the steady-state value, t = 0 corresponds to the moment of switching on the torsional generator.

Electrode potential E is the measure of the change in the Gibbs energy ΔG when an equilibrium reaction proceeds in a galvanic cell made up of electrode being studied and reference electrode:

$$E = -\Delta G/nF \quad (2)$$

where n is the number of electrons transferred in the overall reaction, F is Faraday constant.

E may also be expressed by the Nernst equation through activities, a, of the reaction participants

$$E = E_0 - (RT/nF)\Sigma\nu_i \ln a_i, \quad (3)$$

where ν_i are stoichiometric coefficients in the equation of electrode reaction ($\nu_i > 0$ for reaction products and $\nu_i < 0$ for initial substances), E_0 is the standard electrode potential, $E_0 = (RT/nF) \ln K_p$, K_p being equilibrium constant of electrode reaction, R is the gas constant.

Changing E by 0.01 mV corresponds to the change in Gibbs energy ΔG roughly by 2 J/mol (or 0.02 MeV/ion), i.e. to a very small quantity.

2. Measurements of hydrogen permeability of metals by the electrochemical method. Hydrogen permeability of metallic membranes was studied, employing the Devanathan technique [8]. In this procedure, hydrogen was liberated at the entry side of the membrane in the cathodic reaction $2H^+ + 2e \rightarrow H_2$, some of the atomic hydrogen diffuses to the opposite side of the membrane and is electrochemically oxidized there. Anodic oxidation current is proportional to the flow of hydrogen through the membrane.

The effect of the torsional field generation was studied in the case of hydrogen penetration through membranes made of iron-silicon alloy (3% Si) or Pd after the establishment of stationary flow of hydrogen through the membrane.

Membrane's entry side was cathodically polarized in 0.5 mol/l solution of sulfuric acid, current density ranging from 1 to 50 mA/cm^2 (usually 5 mA/cm^2). As distinct from the results of the electrode potential measurements, the results on hydrogen permeability were not reproducible. If one does lean on the data for annealed Pd (vacuum, 870 K, t = 2h) hydrogen permeability curve for the Pd-membrane may be taken as an example (See Fig. 3).

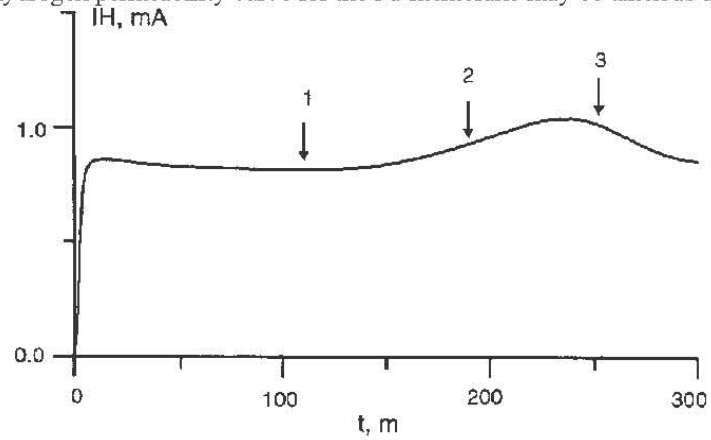

Fig. 3. Effect of torsional field on time-dependence of the flow of electrolytic hydrogen diffusing through the Pd-membrane. Parameters at the entry side of the membrane: Pd/0.5 M H_2SO_4, i_c = 5 mA/cm^2; at the exit side of the membrane: Pd/0.1 M NaOH, E = 0.175 V (against the standard hydrogen electrode). Denoted by arrows are: 1 - switching on the generator, 2 - switching off the genrator, 3 - discharge of solution from the cathodic compartment of the cell.

After switching on the device, changes in the flow of hydrogen I_H would commence at far larger intervals of time as compared to the changes in the electrode potentials. Each changeover of the mode (e.g. varying the modulation frequency) leads to increased slope of I_H vs. t curve (I_H - current of hydrogen flow, t - time). Prolonged after-action effects (approx. 0.5 h) were observed after switching off the generator; hydrogen flow relaxation proceeded very slowly (Fig. 3).

CONCLUSION

Torsional field, affecting reacting particles, shows up (or results) to a greater extent in the formation of hydrides (PdH_x, x = 0.7 to 0.8) and in the characteristics of hydrogen permeability of membranes. The effect is expressed to a lesser degree (or not detected at all) for redox reactions in solution. Torsional field effect is present in the electrochemical systems, forming either intermediate particles adsorbed at the electrode surface or 2D-structures in the underpotential deposition mode ($Cu/CuSO_4 + H_2SO_4$ at $i_c = 0$). This effect disappears when an electric current i_c passes through the system. Explanation of the effects could be found both in the influence of torsional field on the phonon spectrum of a hydrogen-saturated crystal and in the impact on the spin orientation of reacting particles. Filling a tetrahedral or octahedral position, the hydrogen atom deforms the neighboring interstice, thus making possible its preferential filling.

High entropy structures in solutions are less subject to the impact of torsional field (or do not respond to it at all). It is not until the establishment of near order that influence shows itself slightly. The nature of the impact of torsion generators of the types I, II, and III on the electrochemical systems turned out to be qualitatively coincident and therefore their individual action is not considered. Additional experimental work has to be done in order to reveal the regularities of appearance of the effects found.

We will propose the hypothesis that a torsional field is capable of altering the interaction potentials in the electrochemical systems in question, this topic is of interest in the studies of cold nuclear fusion.

In conclusion, one should express optimism about the discovered effects of a torsional field on electrochemical reactions. These experiments should be continued using precision apparatus.

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ELECTROCHEMICAL INSERTION OF HYDROGEN INTO METALS AND ALLOYS

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ABSTRACT

Hydrogen in metals has possible applications in various energy storage devices. For the palladium-deuterium system, excess power production and other anomalous effects have been reported. This study focused on hydrogen and deuterium insertion into palladium and deuterium insertion into various palladium-boron alloys. The condition of the metal surface is a major factor in the insertion of hydrogen or deuterium into palladium or palladium-boron alloys. Cracks or other surface defects prevent high loading levels of hydrogen in metals. The addition of boron to palladium does not affect the initial loading rate but slows further loading to higher levels. The presence of boron in the palladium significantly slows the rate of the deloading process.

INTRODUCTION

Hydrogen in metals has possible applications in rechargeable battery systems, off-peak energy storage for electric utilities, and as the storage of hydrogen as a portable fuel for automobiles and buses. In addition, hydrogen embrittlement and hydrogen-related stress corrosion cracking are very important practical problems for metals and alloys.

Anomalous effects have been reported for the palladium-deuterium system including excess power production. This anomalous power effect apparently requires a loading ratio of D/Pd exceeding 0.85 [1].

This research will investigate the amount of hydrogen and deuterium that can be electrochemically inserted into palladium and palladium-boron alloys. Factors that affect the extent of loading and the rate of the loading and deloading processes will be investigated.

EXPERIMENTAL

The hydrogen or deuterium loading of palladium or palladium alloys was investigated by the weight gain of the electrode during constant current electrolysis in H_2O-LiOH or D_2O-LiOD solutions. The weight gain of the metal (M) due to hydrogen loading can be represented by

$$M + x\,H_2O + xe^- \rightarrow MH_x + x\,OH^- \quad (1)$$

The rate of deloading was also investigated by the loss of weight represented by

$$MH_x \rightarrow M + x/2\,H_2 \quad (2)$$

or by coulometry where the absorbed hydrogen is reacted electrochemically as represented by

$$MH_x \rightarrow M + xH^+ + xe^- \quad (3)$$

The weighing method involved interrupting the electrolysis and removing the electrode from the solution whereas coulometry was performed in the solution. In addition, the use of a sensitive calorimeter determined the rate of the loading process by measuring the power produced during the initial exothermic loading process. For example, ΔH = -35,100 J per mole of D_2 for the formation of PdD_x for $x \leq 0.6$ [2].

RESULTS/DISCUSSION

Initial studies were conducted on palladium rods (1-mm diameter) and palladium sheet electrodes in H_2O + 0.1 M LiOH solutions to test the reliability of the weighing method. Upon interrupting the constant current electrolysis and removing the palladium electrode from the cell, it was found that the loss of weight (Eq. 2) could be readily measured and that the weight change was linear with time. For five or more weighings over a 10-minute period, the plot of the H/Pd ratios versus time was extrapolated back to zero minutes to yield the initial H/Pd loading when the electrolysis was interrupted.

Loading levels of H/Pd $\geq$ 0.7 were readily obtained in all experiments. Both a 1-mm diameter palladium rod (Johnson-Matthey) cathode and a palladium sheet cathode (Tanaka Metals, Japan) were used in these investigations. The highest loading level for the palladium rod was H/Pd = 0.923 while the highest value for the palladium sheet was H/Pd = 0.821. No obvious correlation between the loading level and the current density could be established. The type of anode used in the cell apparently affected the loading level. Higher loading levels were obtained using a platinum anode than when a nickel anode was employed. The H_2O-LiOH solution eventually became dark due to corrosion products when the nickel anode was used.

Although a loading level of H/Pd = 0.7 was readily obtained in all experiments using palladium cathodes, only a few experiments yielded H/Pd ratios approaching 0.9. The highest loading occurred following the heating of the loaded palladium rod with a heat gun that caused it to glow red due to a run-away exothermic reaction of the hydrogen exiting the surface with oxygen from the air.

The study of the H/Pd ratio over a 21 day period for a palladium rod cathode showed several peaks and valleys in the loading ratio versus time. The H/Pd ratio varied from 0.79 after 3 days to a low of 0.72 at 6 days and a maximum of 0.92 at 16 days. There was no obvious correlation between the loading ratio and any experimental variable. For most experiments, the change in H/Pd after interrupting the electrolysis was generally about -0.01 per minute.

A new calorimeter designed and built at China Lake [3] was used to measure the heat of absorption of deuterium into the palladium rod cathode. This result is shown in Fig. 1. A power output of approximately 6.5 mW is observed for 2 hours. This yields 47 Joules that compares very favorably to the expected 44 Joules based on the cathode size (1 mm x 4.3 cm), a loading level of $PdD_{0.6}$, and using the reported value of ΔH = -35,100 J per mole of D_2 [2]. Fig. 1 shows that most of the loading up to D/Pd = 0.6 is completed within 2 hours of the start of the electrolysis. Further loading beyond the D/Pd = 0.6 ratio yields a discontinuity in the enthalpy value, and the loading process becomes endothermic [2]. No endothermic behavior, however, was detected in our experiment (Fig. 1).

Loading studies for two palladium-boron alloys, both containing 0.75 weight % boron, are shown in Table 1. The loading process is much slower with the boron present than observed with pure palladium. While loading levels of D/Pd = 0.6 could be attained within a few hours for palladium cathodes, nearly 12 days of electrolysis is required to reach this loading level for the palladium-boron alloy (Table 1). Judging from Table 1, the Pd-B alloy in cell C slowly loaded to higher levels. After 100 days, the D/Pd ratio was 0.85 for the alloy in cell C but only 0.63 for the alloy in cell D. **A surface flaw caused this difference**. The Pd-B alloy used in cell D had a long folded-over metal region produced by the swaging of this very hard material. This acted as a long crack in the surface. **Cracks or similar surface defects are a major factor in preventing high hydrogen or deuterium loading levels.**

Further experiments investigated the effect of the boron concentration on the D/Pd loading level. Table 2 presents loading studies by the weighing method for Pd-0.50 weight % B and Pd-0.25 weight % B cathodes. Loading to the D/Pd = 0.6 level becomes considerably faster as the amount of boron is decreased as shown in Tables 1 and 2. Higher D/Pd ratios are obtained initially for the alloys containing the smaller amount of boron.

Calorimetric studies at China Lake showed that the initial exothermic loading of deuterium into the Pd-B alloys is nearly as fast as observed with pure palladium cathodes. This was a surprising result. Further loading to higher levels, however, appears to become very slow for the Pd-B alloys compared to the palladium cathodes (Tables 1 and 2).

Coulometric measurements of the loading were attempted for the palladium-0.75 weight % B alloy. The currents obtained by potentiostatically controlling the cell voltage were only 2-4 mA, hence less than 10% of the deuterium could be reacted electrochemically (Equation 3) even after 28 hours of electrolysis. Measurements by the weighing method also showed very slow deloading rates for the Pd-0.75 weight % B alloys, i.e., the D/Pd ratio change was less than -0.001/minute. **This is more than ten times slower than observed for palladium electrodes**. It took 2 weeks to reach an equilibrium weight for these alloys.

Deloading studies by the weighing method for the Pd-0.50 weight % B and Pd-0.25 weight % B alloys are shown in Table 3. The deloading rate again is much slower than for palladium cathodes. About 10 days was required to reach an equilibrium weight.

Tables 1-3 show that small amounts of boron added to the palladium can produce major changes in the deuterium deloading rates. The initial rates of loading, based on calorimetry, are similar for palladium and palladium-boron alloys. Perhaps boron accumulates in the grain boundaries during the initial loading and then hinders both the further ingress and egress of hydrogen or deuterium into and out of the metal lattice.

CONCLUSIONS

Loading and deloading of hydrogen and deuterium in palladium and palladium-boron alloys can be readily studied by the weighing method. Cracks or other surface flaws affect the degree of loading that can be obtained. **Small amounts of boron alloyed with palladium can slow the deloading rate by a factor of ten or more.**

ACKNOWLEDGMENTS

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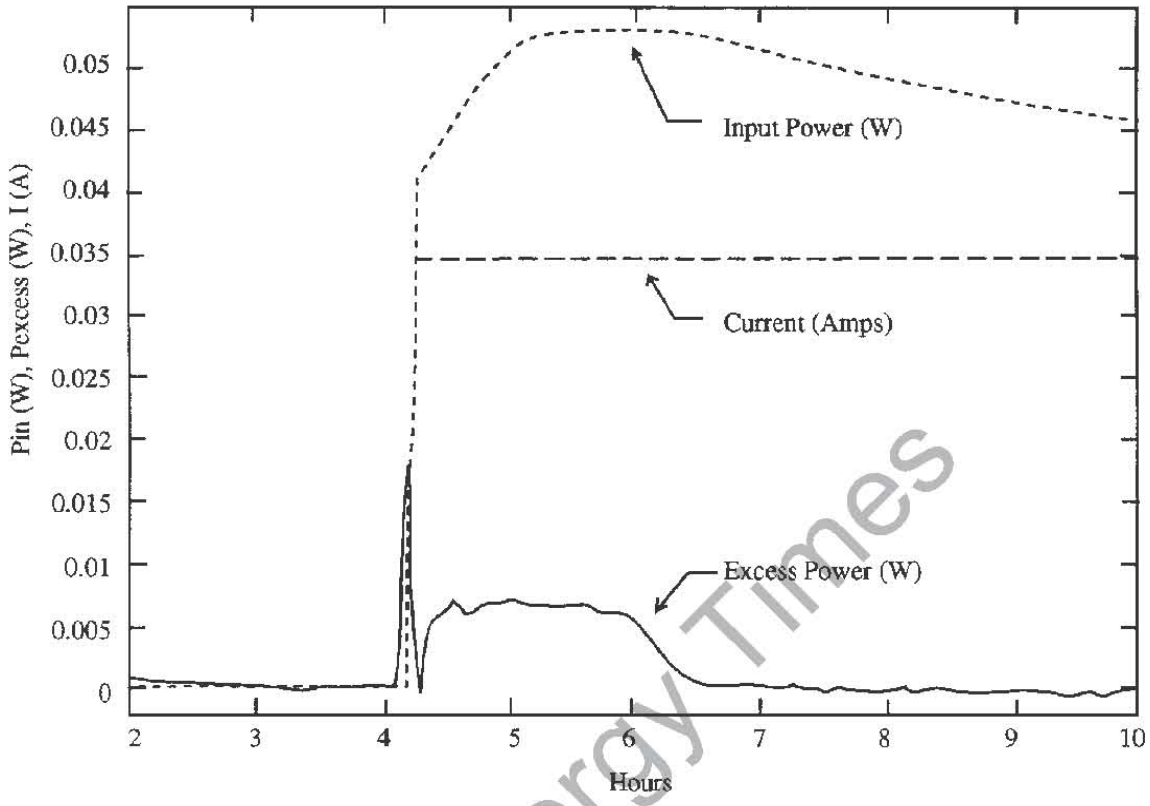

Fig. 1. Measurements of the Exothermic Heat of Absorption of Deuterium into a Palladium Wire Cathode (1 mm x 4.3 cm) using the New Calorimeter Developed at China Lake.

Table 1. Loading Studies by the Weighing Method

Time (Days)	Pd - 0.75% B (Cell C)	Pd = 0.75% B (Cell D)
7	0.580	0.550
12	0.614	0.594
100	0.85	0.63

Table 2. Loading Studies by the Weighing Method Following 5 Days and 10 Days of Electrolysis.

Electrode	Xo (5 Days)[a]	Xo (10 Days)[b]
Cell A – Pd - 0.5% B	0.643	0.640
Cell B – Pd - 0.5% B	0.604	0.652
Cell C – Pd - 0.25% B	0.692	0.716
Cell D – Pd - 0.25% B	0.647	0.695

[a] I = 50 mA for 5 days.

[b] I = 100 mA for the second 5-day period.

Note: Microscopic examinations showed surface nicks and scratches but no major flaws on electrodes.

Table 3. De-loading Studies by the Weighing Method

Time (Hours)	Pd - 0.5% B (Cell A)	Pd - 0.5% B (Cell B)	Pd - 0.25% B (Cell C)	Pd - 0.25% B (Cell D)
0	0.617	0.643	0.687	0.687
12	0.490	0.497	0.518	0.512
36	0.350	0.368	0.446	0.367
67	0.228	0.261	0.215	0.190
112	0.152	0.161	0.108	0.069
181	0.100	0.051	0.034	0.010
282	0.065	0.003	0.010	0.003

ANOMALOUS ISOTOPIC DISTRIBUTION IN PALLADIUM CATHODE AFTER ELECTROLYSIS

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ABSTRACT

It was confirmed by several analytic methods that reaction products with mass number ranging from 20 to 28, 46 to 54, and 72 to 82 are produced in palladium cathodes subjected to electrolysis in a heavy water solution at high pressure, high temperature, and high current density for one month. Isotopic distributions were radically different from the natural ones.

INTRODUCTION

Nuclear reactions in a solid electrode at ordinary temperatures have been reported by many experimenters since 1989. However, this phenomenon is still not well accepted among researchers because of poor reproducibility and control. What is urgently needed now is to obtain precise and quantitative relationships between potential nuclear reactions and their corresponding reaction products. If nuclear reactions induced by electrochemical reaction occur in solid electrodes, there must be clear evidence such as the evolution of radioisotopes and radiation. Moreover, the evolution of the reaction products should be explained in terms of the nuclear mechanisms. In this work, evidence which indicates the occurrence of some nuclear reactions is presented, in the form of transmuted elements within the cathode and on the cathode surface. The anomalous isotopic distribution of these elements shows they do not come from contamination. For example, natural copper is 70% ^{63}Cu, and 30% ^{65}Cu. But the copper found in the cathode was 100% ^{63}Cu, with no detectable levels of ^{65}Cu. Natural isotopic distribution varies by less than 0.001% for copper.

EXPERIMENTAL

Palladium rods used were of high purity (99.97% min.) supplied by Tanaka Noble Metals, Ltd. Impurities in the sample were as follows: B: 110 ppm, Si: 10, Ca: 9, Cr: 10, Cu: 6, Ti: 5, Ag: 44, Mg: 1, Pt: 20 and Au: 23. Nothing more was detected by atomic absorption photospectroscopy. Heavy water was supplied by Showa Denko, Ltd. It is 99.75% pure and includes 0.077 micro Ci/dm^3 of tritium. The heavy water was purified once in a quartz glass distiller. Reagent grade lithium hydroxide was obtained from Merck, Ltd. Impurities in the reagent were specified as follows: Li_2CO_3: 2% max, Cl: 0.05%, Pb: 20 ppm, Ca: 200, Fe: 20, K: 200 and Na: 200. The anode and recombiner catalyst were, respectively, a high purity (99.99%) Pt plate and a Pt mesh. The Pt metal is specified to contain impurities as follows: Rh: 18 ppm, Si, Cr and Pd: 2 ppm, Au, Ag, B, Ca, Cu and Fe: less than 1 ppm. Other impurities were under the limits of detection.

Electrolysis was performed in a closed cell made of stainless steel. The cell inner wall was coated with 1 mm thick Teflon. The details have been described elsewhere [1]. Before the electrolyte was added to the Pd cell, it was pre-electrolyzed with Pt electrodes at 1 A and 150°C for 6 x 10^5 s (7 days). Electrolysis experiments were performed at a current density of 0.2 A cm^2 or total current of 6.6 A at 10^5 n for 2.76 x 10^6 s (32 days). The sample electrodes were analyzed for element detection by energy dispersive X-ray spectroscopy (EDX), Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS) and electron probe microanalyzer (EPMA).

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RESULTS

Several elements were detected in the Pd electrode by the EDX method. Fig. 1 shows typical results before and after electrolysis. The evolution of Pt, Cr, Fe, Cu and other elements were clearly seen. The amounts detected by EDX, AES and SIMS averaged together are shown in Fig. 2. Amounts for all elements were calculated by the peak height of the estimate methods. Amounts were shown normalized with the Pd peak set as 100. Typical counts by EDX and SIMS ranged from 102 to 106 and were 10 to 100 times higher than the background counts. Thus, the presence of Ca, Ti, Cr, Mn, Fe, Co, Cu, Zn, Cd, Sn, Pt and Pb was confirmed. AES and SIMS measurements were also made after bombardment by Ar^+ or O_2^- ions, thus removing surface layers, but **the element concentrations at 1 micro m below the electrode surface were almost the same as at the surface**. Many holes and cracks were observed in the bulk layer, having 1 to 10 micro m of opening size. The same elements, having almost the same concentration, were also found at the surface. These elements are mostly grouped in three ranges of atomic numbers: from 20 to 30; 46 to 54; and 72 to 82.

The SIMS analysis showed other elements: As, Ga, Sb, Te, I, Hf, Re, Ir, Br and Xe. These elements, except Xe, are difficult to detect by AES and EDX because the peaks are very close to each other, or lower than the limits of detection. Xe is naturally difficult to detect by EDX because it is in the gas state. The SIMS count numbers ranged from 10^3 to 10^6 where the background counts were as low as ~10, so we have confidence in these results. In Fig. 2 we show the peak intensities normalized with the peak of palladium as 100%. The intensity of Xe was 10 times larger than Pd; it may be that the gas was released by bombarding with O_2- ions which caused a temperature rise at the sample. Large differences in isotopic distributions compared with the natural distributions were observed by the SIMS method for Cu, Zn, Br, Xe, Pd, Cd, Hf, Re, Pt, Ir and Hg. Elements of mass number between 39 and 82 are shown in Fig. 3; Cr, Fe and Cu showed large shifts in isotopic ratios. Especially notable was the fact that no ^{65}Cu peak was observed. **Except for a few cases, in generally the isotope abundances are higher for odd mass numbers and lower for even ones, as compared with the natural ratios**. In Fig. 4, for mass numbers between 100 and 140, Cd and Xe were shown to have large shifts in abundances. In Fig. 5, for mass number between 172 and 208, large shifts were seen for Hf, Re, Ir, Os and Hg.

Generally speaking, heavier isotopes increased compared to the natural ratio, and lighter isotopes decreased. For example, ^{24}Mg went from 79% down to 74%, while ^{25}Mg went from 11% to 12%. This rule did not hold for some elements with few isotopes. ^{63}Cu increased while ^{65}Cu was absent; ^{47}Ti increased while ^{48}Ti decreased. The pattern is confusing for ^{111}Cd to ^{114}Cd: a slight decrease, a giant increase, a large increase and compensating drop in heaviest isotope, number 114. Data from some elements are not shown in Figs. 3 to 5 because their peaks overlapped with those of other elements, or because they showed only a small difference with natural abundance.

Neutron intensity and energy measurements were carried out simultaneously, in parallel. The neutron evolution rate was sporadic and weak, as previously reported [2], with levels of ~0.4 counts per second. No gases such as He, O_2 and Ar were detected. Excess heat generation was less reproducible, varying from 10^5 to 10^7 joules. [3]

DISCUSSION

Essentially the same phenomenon was confirmed five times with high reproducibility at high cathodic current density, above 0.2 A/cm^2. Current density ranged from 0.2 to 0.6 A/cm^2. Different isotope distributions were obtained, depending on the current density. This will be described more fully in an upcoming paper. It can hardly be imagined that all of the elements found were impurities in electrolyte, electrode, or cell. Even if we suppose that all impurities in the system accumulated in the cathode, the amount would be 10 to 100 times smaller than the total amount we detected. Furthermore, it is simply impossible to explain the shifts in the isotopic distribution. Hence, it must be concluded that some novel reactions occurred, resulting in the reactants which were found abundant in the electrolyte and electrode material. We assume the cathode palladium was the starting material for these reactions, but it is possible that impurities and other cell components such as Li, D_2O, Pd, Pt, K, Na, Ca, B, C, Ag and Fe may have provided the starting material for the nuclear reactions.

The palladium surface became rough and porous after several weeks of electrolysis, probably due to hydrogen attack. The current may have increased in such roughened surface areas, which would in turn cause a larger reaction and a higher concentration of the reaction products. Enyo [4-6] reported that the effective hydrogen pressure at the

hydrogen evolving electrode depends upon the hydrogen atom recombination process which follows the water discharge process. The division of the overpotential between these two steps may be important. It was suggested that at Pd electrodes in alkaline solution the effective hydrogen pressure may rise as high as 10^6 atm [7,8]. There may be further increases at local points on a heterogeneous surface. One may even speculate that the hydrogen isotope nucleus sometimes closely approaches the medium nucleus [9]. An estimate by Nernst Equation indicates that 5 x 10^4 atm of pressure may be realized at 140 mV of overpotential at the electrolysis current density of 200 mA/cm^2 on a flat palladium surface [10]. Furthermore, the pressure distribution depends on the roughness of the surface, because local current density and the partition of overpotential components may vary with roughness.

There are several reports [11-13] of evolution of elements by electrolysis. However, only a few [14, 15] demonstrated shifts in isotopic abundance. For a gold electrode [16], which also generated various elements by cathodic electrolysis, different isotopic distributions were seen. In this case also, the reaction sites were unevenly distributed on the surface. Typically, the active points may have occupied about 10^{-6} cm^2 areas and numbered 10^4 to 10^5 per cm^2 at the surface. Thus, the current is likely to be concentrated at localized points 10 to 100 times higher than average. Such high pressure can induce neutrons to enter into heavy nuclei and successively form an unstable heavy nucleus [17]. If the reactions start from palladium as the electrode material, fusion and fission may take place simultaneously. Several possible reactions might be considered:

$$^{108}_{46}Pd + 2^2_1D \rightarrow {}^{108}_{46}Pd^4_2 \rightarrow {}^{116}_{48}Cd$$

$$^{108}_{46}Pd + 4^2_1D \rightarrow {}^{108}_{46}Pd^8_4 \rightarrow {}^{116}_{50}Sn$$

$$^{108}_{46}Pd + 8^2_1D \rightarrow {}^{108}_{46}Pd^{16}_8 \rightarrow {}^{124}_{54}Xe$$

$$^{102}_{46}Pd + 8^2_1D \rightarrow {}^{102}_{46}Pd^{16}_8 \rightarrow {}^{118}_{54}Xe \rightarrow {}^{118}_{50}Sn + 4\beta^-$$

$$^{104}_{46}Pd + 8^2_1D \rightarrow {}^{104}_{46}Pd^{16}_8 \rightarrow {}^{120}_{54}Xe \rightarrow {}^{120}_{52}Te + 2\beta^-$$

$$^{105}_{46}Pd + 8^2_1D \rightarrow {}^{105}_{46}Pd^{16}_8 \rightarrow {}^{121}_{54}Xe \rightarrow {}^{121}_{51}Sb + 3\beta^-$$

$$^{106}_{46}Pd + 8^2_1D \rightarrow {}^{106}_{46}Pd^{16}_8 \rightarrow {}^{122}_{54}Xe \rightarrow {}^{122}_{52}Te + 2\beta^-$$

Here, the subscript at the left-hand side of the intermediates represents the proton number and the top superscript represents the total nuclear number which is connected with nucleus as the hollow atom. It can be assumed that these particles will stay in a stable orbit according to their quantum spin number as the same concept with electron orbits. The connecting nuclei are caught into medium nuclei by the force of high external pressure.

Other reactions have to be assumed because many light elements were observed. They may be as follows:

$$^{102}_{46}Pd + 2^2_1D \rightarrow 2^{51}_{23}V + {}^4_2He$$
$$\rightarrow {}^{50}_{22}Ti + {}^{52}_{24}Cr + {}^4_2He$$
$$\rightarrow {}^{48}_{20}Ca + {}^{57}_{26}Fe + {}^4_2He$$

Generally, one can write the fission reactions as follows:

$$^{102}_{46}Pd + 2^2_1D \rightarrow {}_nA + {}_{46-n}B + {}^4_2He$$

In the case of platinum deposited from the positive electrode to the Pd electrode surface, some reactions may be involved, such as:

$$^{196}_{78}Pt + 2^2_1D \rightarrow {}^{196}_{78}Pt^4_2 \rightarrow {}^{200}_{80}Hg$$

$$^{196}_{78}Pt + 4^2_1D \rightarrow {}^{196}_{78}Pt^8_4 \rightarrow {}^{206}_{82}Pb$$

They may induce fission reactions as follows:

$$^{194}_{78}Pt + 2^{2}_{1}D \rightarrow {}^{136}_{54}Xe + {}^{58}_{26}Fe + {}^{4}_{2}He$$

$$^{195}_{78}Pt + 2^{2}_{1}D \rightarrow {}^{136}_{54}Xe + {}^{59}_{26}Fe + {}^{4}_{2}He$$

$$\downarrow$$

$$^{59}_{27}Co + \beta$$

$$^{196}_{78}Pt + 2^{2}_{1}D \rightarrow {}^{136}_{54}Xe + {}^{60}_{26}Fe + {}^{4}_{2}He$$

$$\downarrow$$

$$^{60}_{28}Ni + 2\beta$$

Atomic numbers of 20, 28, 50 and 82 are called magic numbers. Here, $_{54}{}^{136}$Xe nuclei are abnormally increased, and hence the number of neutrons changes to magic number 82, and especially stable nuclei are selectively produced. In this way, the isotopic distributions of the products after electrolysis can be explained in terms of the difference of binding energy of the nuclei.

It must be admitted that these reactions have no solid, detailed theoretical basis yet, but in broad terms this can explain most of the elements which were observed. One may also imagine that as such transmutation reactions were presumably taking place during the electrochemical process, they are likely to be connected with other phenomena such as hydrogen embrittlement and local corrosion.

CONCLUSION

Anomalous evolution of various elements in palladium electrodes was confirmed after high current density cathodic electrolysis under high temperature and pressure for a long time. The following conclusions were drawn:

(1) The mass number of the evolved elements was distributed roughly in three groups: 20 to 28, 46 to 54 and 72 to 82, with the amounts, respectively, >50%, 10% and <5% compared to palladium.

(2) These evolved elements were found on the surface, and also in the near surface bulk of the electrode in amounts 10 to 100 times smaller.

(3) Many evolved elements accumulated in holes and cracks on the electrode which formed during electrolysis.

(4) Some of the evolved elements have isotopic distributions drastically different from natural ones, especially for Cu, Zn, Br, Xe, Pd, Cd, Hf, Re, Pt, Ir and Hg.

(5) Gaseous Xe was noteworthy because it was so abundant. Xenon is particularly unlikely to be a contaminant because metals do not absorb noble gases, and because the cathode was degassed in a vacuum at 473°K for 20 hours.

(6) The elements in the bulk layer changed in concentration with depth and showed shifts of isotopic distribution.

(7) Light elements such as O, C, Ca, Na, Mg and Al showed small isotopic shifts.

(8) Ni and Co were also confirmed but their isotopic distribution could not be measured because their SIMS peaks overlapped with those of other elements.

(9) The isotopic distributions of Pd and Pt were also shifted.

(10) We conclude that nuclear reactions must have occurred during the electrochemical process.

ACKNOWLEDGMENT

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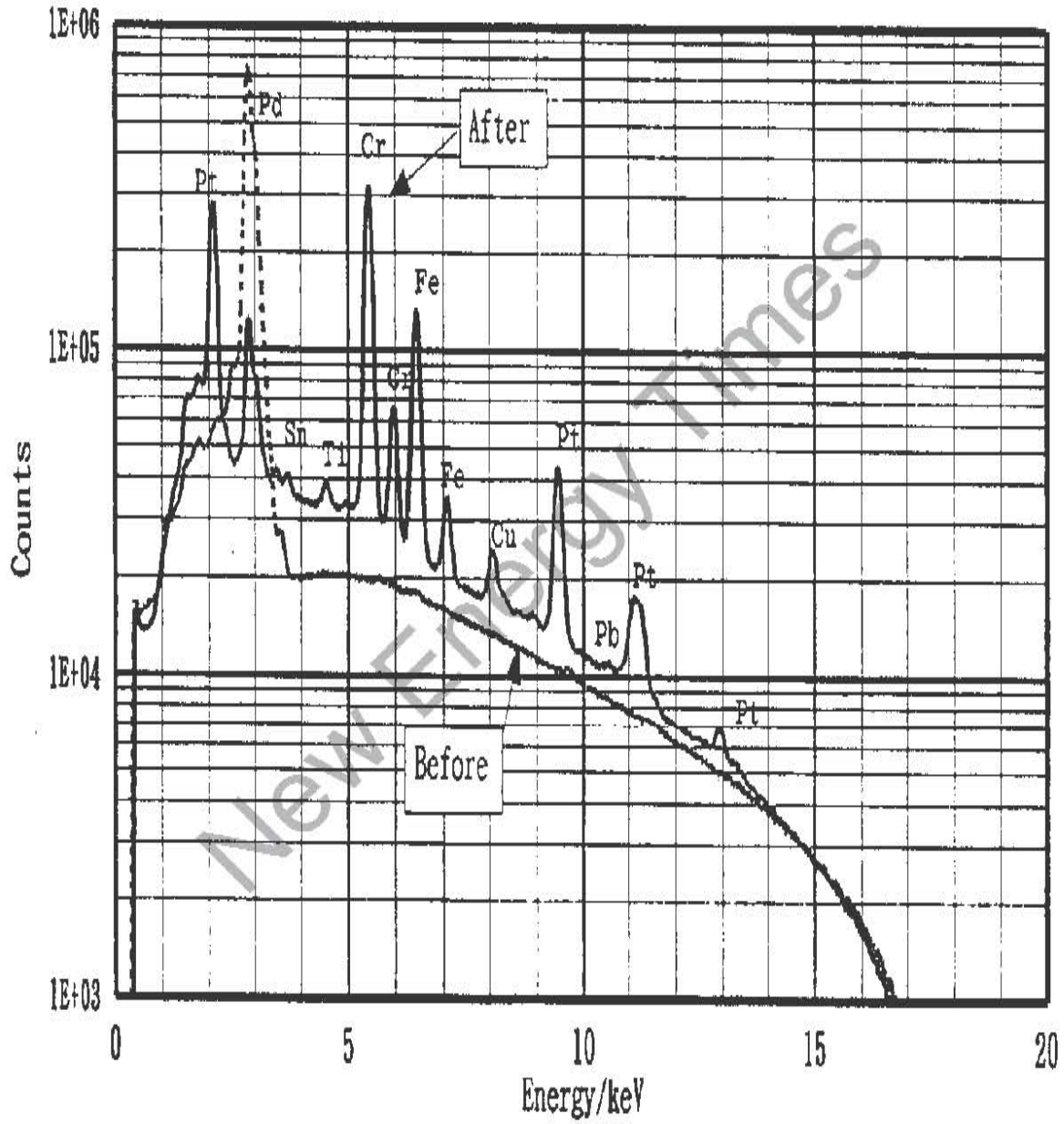

Fig.1 EDX spectra for Pd rod before and after electrolysis

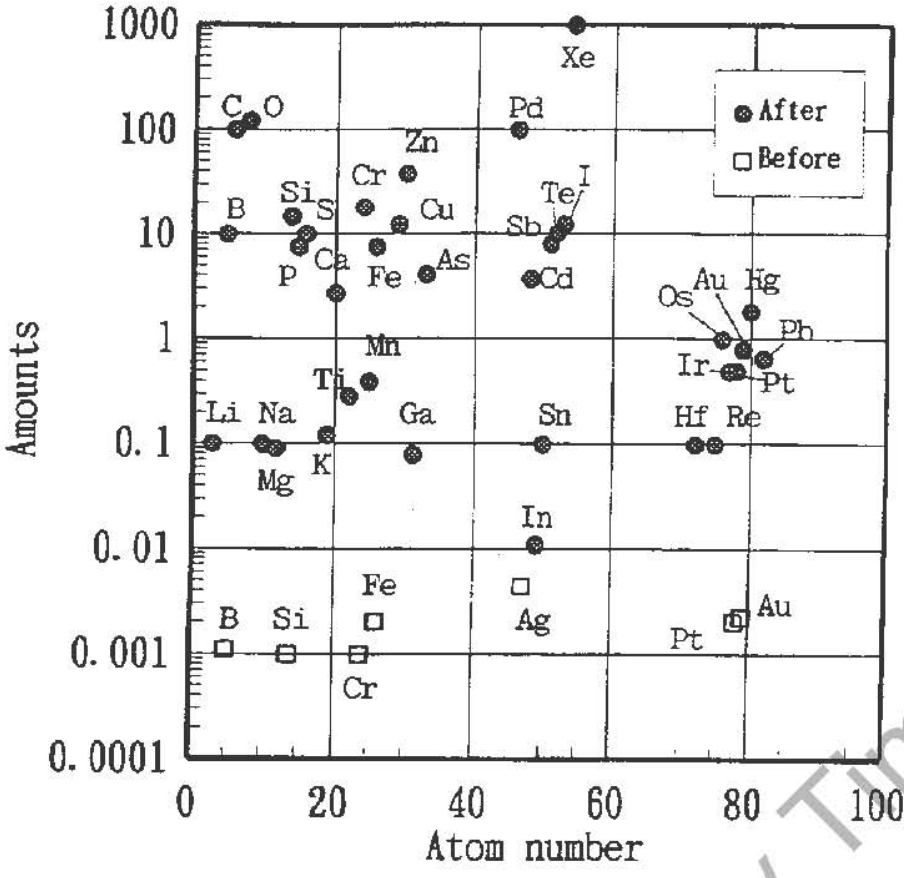

Fig.2 Amounts of elements obtained various measurements

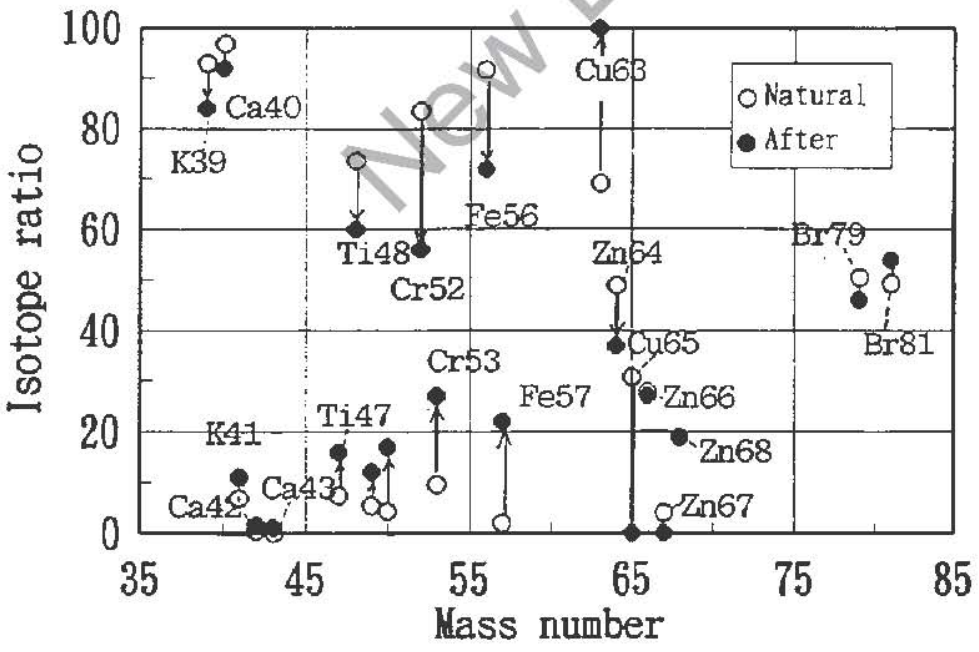

Fig.3 Changes of isotope ratio for reaction products of mass number between 39 and 81

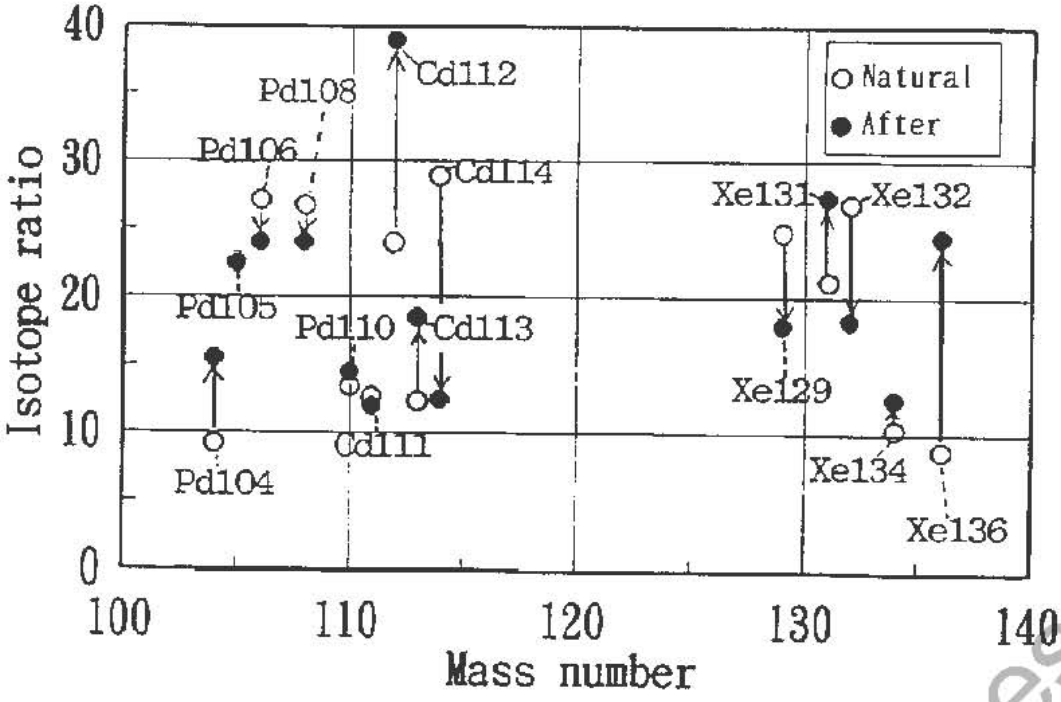

Fig.4 Changes of isotope ratio for reaction products of mass number between 104 to 136

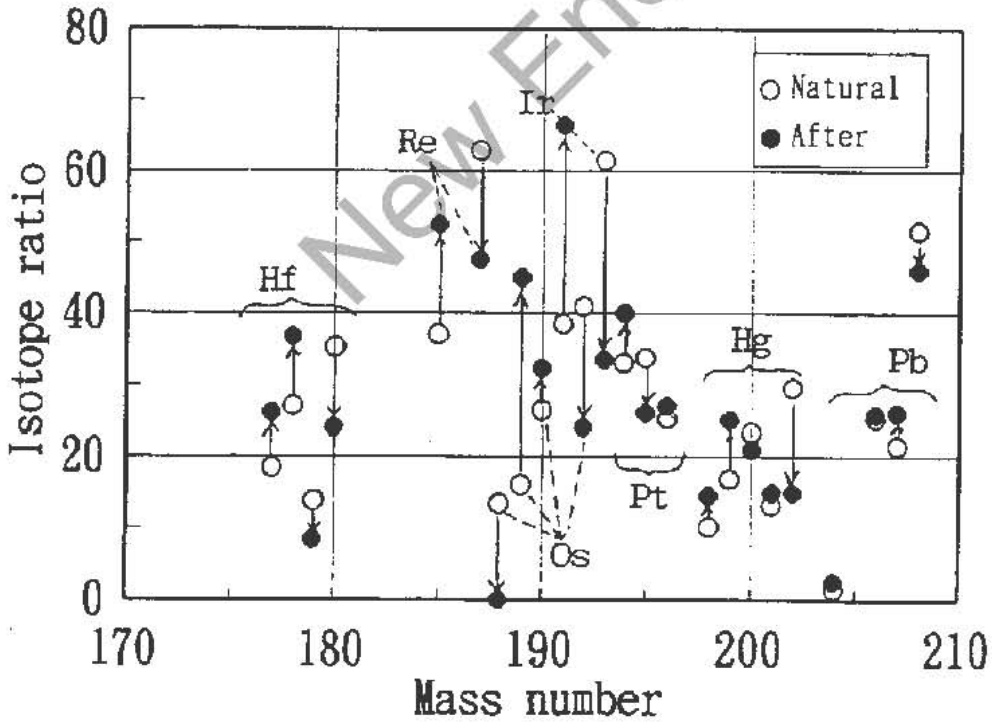

Fig.5 Changes of isotope ratio for reaction products of mass number 177 to 208

THE ENERGY RELEASE MECHANISM OF NEWLY-FORMED ALPHA BOSONS IN A QUANTUM CRYSTAL LATTICE, (OR "WHY THERE ARE NO 23.8 MEV GAMMA RAYS FROM D + D = ^{4}HE SPIN-COHERENT COLD FUSION REACTIONS")

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ABSTRACT

This paper provides a description of the physical process by which newly-formed alpha bosons lose the energy of fusion to the metal hydride lattice in a typical stimulated anharmonic fusion. Contrary to popular belief, there is no 23.8 MeV gamma ray. The paper also stands as a correction to the phonon release mechanism of Schwinger. The actual energy release mechanism is more complicated than a single gamma ray. Initially two circularly polarized gammas are emitted from the quark bag collapse of two 4.38 fermi radii deuterons to a single 2.5 fermi radius alpha boson. The intensity of these gamma rays is immediately strong enough, in the Coulomb field of the resultant alpha boson, for intense micro-episodic pair production. The 23.8 MeV energy of fusion allows for 2 electron-positron pairs to be produced in a Dirac-like process out of the vacuum near the charge density of the resultant alpha boson. These electron positron pairs speed out from the point of creation in momentum and energy conserving directions. They are quickly scattered by the lattice and contribute to the enthalpy of the lattice in several distinct ways. The electrons and positrons scattered by the palladium nuclei and the deuterons emit Bremmstrahlung photons. When scattered against the electronic charge distribution of the lattice they emit Cerenkov photons. They may also engage in ionizing and Compton collisions with other electrons. The electrons engage in classical scattering and contribute to Joule heat in the conduction band. The positrons travel a short while contributing themselves to Joule heat, being scattered by the Coulomb field of the lattice, and then establish a briefly-lived atom of positronium. They are then annihilated in a matter- antimatter collision with a lattice electron (conduction or valence band). The annihilation radiation of the matter-antimatter leptonic collision (positron annihilation) then is a contributor to the lattice enthalpy. The annihilation radiation results in two oppositely-directed x-rays with an energy of 511,000 electron-volts each. These X-rays are Compton scattered by electrons and ions inside the lattice and are reduced in energy after each Compton collision.

INTRODUCTION

It can be easily shown using the correct matter wave equations that the form of the combined Coulomb-Yukawa Potential can be modified to the extent of permitting a moderately high fusion tunneling rate between deuterons in a deuterated metal lattice. To the extent that the spins of the two deuterons may be opposed in the fusion process, the nuclear reaction will proceed according to D + D = He(4) and not according to one of the more well-known Bethe fusion pathways which involve Oppenheimer-Philips nucleon stripping. A central puzzle to the problem of cold fusion has been understanding what happens to the Einstein mass energy of fusion after this happens. Where does it go? Is it carried off by the kinetic energy of the resultant alpha particle, is it given up to phonon vibrations of the lattice, or is it carried off by a gamma ray?

A number of researchers have shown that helium-4 production accompanies anomalous heat production in palladium deuteride lattices, including Miles at China Lake [1,2]. It is now fairly well agreed that helium-4 represents one of the primary components of the nuclear ash from a nuclear fusion reaction(s) occuring inside the lattice and warming it up. (Applying Ockham's Razor, one reaction which is occuring is likely to be a D + D = ^{4}He reaction and not some more exotic process.) A central puzzle has remained as to exactly what the "warming up" process is. How is the nuclear fusion energy convened to heat? Eventually, of course, the warming up process is pictured as an irreversible random, incoherent, chaotic dance of the lattice electrons and ions which gives macroscopic heat, but is there any way that this end process can be decoupled from the original nuclear process so that lattice phenomena which add to the heat production process can be reinforced and lattice phenomena which are parasitic to it can be eliminated? Clouding an answer to this question have been the claims of many researchers that the D + D = ^{4}He

nuclear reaction channel is accompanied by the release of a single gamma ray of 23.8 MeV energy. This claim is made not only by newcomers to the field, but it has also appeared in some nuclear physics textbooks.

Since there have been no sightings of 23.8 MeV gamma rays, the fusion process itself is suspect. Where are the 23.8 Mev gamma rays if what is happening is D + D = ^{4}He?

The belief that a single gamma ray is the only way a D + D = ^{4}He fusion can lose its energy, however, is simply erroneous as simple consideration of Racah Algebra and angular momentum dictates.

ENERGY PRODUCTION VIA QUARK BAG TRANSFER AND COLLAPSE

As is well known, the deuteron is a loosely-bound structure consisting of a proton and a neutron with a radius of approximately 4.31 to 4.38 fermis. The intrinsic quantum spin of the deuteron is either plus or minus 1 *h-bar. Leaving aside the important questions of nucleon isopin exchange, the elliptical shape of the deuteron, and the anomalous magnetic moment of the deuteron, the structure of the deuteron is remarkable because each of its nucleon constituents actually spends an appreciable amount of its time beyond the generally accepted range of the nuclear strong force which is usually given as 1.2 - 1.5 fermis. The nuclear matter of the deuteron is thus pictured as an idealized fermi gas in a state of great agitation and violent motion. The nuclear matter of the alpha boson, on the other hand, is completely different in its makeup. **Although the alpha nucleus ("alpha boson") has twice as many nucleons as a deuteron, it occupies only 18% of the volume of a single deuteron and only 9% of the volume of two deuterons**. As opposed to the deuteron matter which is tenuously distributed, the alpha boson is extremely hard and compact. And spinless. Its only degree of freedom in an electromagnetic field is translational; it has no multipole moments, either electric or magnetic. Its internal structure cannot be probed by the radiation field. (In fact, to the extent that it does have any three-dimensional internal structure, it can only be probed by extremely high energy leptonic scattering.) The nuclear matter of the alpha nucleus exists in a special, rather enigmatic state known as a Bose Condesate. The difference between the structure of nuclear matter found in a deuteron and that found in an alpha boson is often likened to the difference which exists between the gas phase and the solid phase of a substance in the macroscopic world. Although there are other so-called "magic number" nuclei with completed quantum "shells", the alpha boson is the simpliest and most fundamental of them all. The extremely large binding energy of the alpha boson and the rather weak binding of the deuteron means that a very large amount of energy can be released from the reaction channel D + D = ^{4}He. The condition of stringent deuteron spin coherency imposed by the lattice allows this reaction to occur with much greater frequency than it can in free space.

The fusion of two deuterons to form an alpha boson can be pictured as the coming together of two separate quark bags to form a single quark bag and then the rapid collapse of this newly-formed quark bag. This can occur when two deuteron quark bags briefly "touch" each other during a tunneling episode. They do not really have to "touch" each other, of course, since the Yukawa Potential is not really a bag, but a quantized force field which extends to infinity and AT infinity, either curves back upon itself or vanishes, depending on the particular space-time curvature assumed. The normal conception of the interior of the quark bag as consisting of an infinite potential such that all interior quarks are always totally internally reflected upon collisions leading to the observed phenomena of quark confinement is all well and good. But the quark is still a quantum particle which cannot be localized below its deBroglie wavelength near the bag's boundary and hence the virtual pion "clouds" which are found near the nucleus.

The total rest energy of a single quark bag, equal to the mass of the corresponding hadron, is:

$$M = \Sigma_i [N_i^* (m_i^2 + x^2 / R^2)^{0.5}] + (B^* 4^* \pi^* R^{3/3}) - Z_0/R + \Delta R(m) + \Delta E(e)$$

energy of the individual quarks — *volume energy of the bag* — *zero-point renormalization* — *color interaction energy*

where N_i is the number of quarks and antiquarks with mass m_i of a given flavor i contained in the hadron and Z_o is an adjustable parameter.

In the case of a deuteron we know that the total quark bag rest energy is 13.1359 MeV (relative to Carbon 12 = 0). Assuming a system of two quark bags consisting of the two deuterons, we get for the total rest energy just 26.2718 MeV (relative to carbon 12). The rest energy of the alpha boson is 2.4248 MeV (relative to Carbon 12). The

difference in rest energies (i.e., 23.8470 MeV between the two deuteron system and the alpha boson system is emitted as light. The exact character of the light emitted (two-quanta, one-quanta, helicities, etc.) depends intricately on all of the different terms in the expression for the quark bag energy.

In general, the quark bag collapse can be pictured as the merging of two regularly well-behaved eigenfunctions, the two deuterons. The two deuteron eigenfunction can be deconvolved to the separate base states which represent each deuteron. Each deuteron's eigenfunction can be further deconvolved into quantum base states (such as what Feynman talks about in Chapter 10 of Vol. III of the Lectures Series) representing each individual quark. However, this is a complicated task which is beyond the scope of this small report and so we will develop a simpler approach.

THE GROUND STATE AND EXCITED ENERGY LEVEL STATES OF THE ALPHA BOSON

If one is interested in the frequency spectrum of electromagnetic radiation emitted from the above fusion reaction (i.e., "quark bag transfer and collapse"), one naturally looks to the construction of a proper Grotrian diagram for helium-4. That is the normal way to figure out how a quantum object (or system) loses its energy. By picturing the object in both ground and a manifold of excited states and by constructing the selection rules which operate between those states we can figure out what frequencies of light it will emit (actually the process is normally done in reverse, but forget about that for awhile). We know what the ground state of the alpha boson looks like, at a binding energy of 23.8470 MeV, and we know what its most excited state looks like it is, in the limiting case, simply two separate deuterons which have not fused yet, at a binding energy of 2.224 MeV each. What do the intermediate energy states look like, the intermediate energy states of the so-called "compound nucleus"?

The answer is that there aren't any! You can look through literally dozens and dozens of the best nuclear physics textbooks around (I did!) and while you will find numerous discussions of the alpha particle, you will never find any Grotrian diagrams showing how the quantum alpha system cascades down in energy, merrily emitting photons along the way. The compound nucleus model of a nuclear reaction pathway simply breaks down completely in the case of alpha boson formation from two spin-opposed deuterons.

How then does a newly formed alpha boson lose its energy?

This process remained a mystery to me for quite some time. I searched for months for this small laeunae of knowledge because in a sense it is key to the whole question of D+D "cold fusion."

INITIAL RELEASE OF THE TWO GAMMA RAYS

The deuteron is not a spherically symmetric agglomeration of nuclear matter but is rather ellipsoidal in shape with something like the ends of little d-orbitals protruding from this ellipsoid. The ellipticity is very low, something on the order of a few percent, (eta = (b-a)/(b+a) = +0.095; where b = major axis (fermis) and a = minor axis (fermis)) so the deuteron is almost spherical. The spin axis of the deuteron is aligned along the major axis of the cigar-shaped ellipsoid. The spin of the deuteron is +1 which makes it a composite boson. Interchanging two bosons will not affect the parity of the matter wave assemblage of two or more bosons. But the plus or minus one spin does make it an identifiable boson, unlike a spin zero fundamental boson alpha. The anomalous quadrapole moment and s-d hybrid orbital structure of the deuteron has been adequately explained by the resonant theory of a colorless quark structure composed of extremely relativistic quarks of up and down flavors which can project virtual pions around the central agglomeration of nuclear matter. Rearranging the protruding d orbitals and the ellipsoidal shapes of two deuterons into a single spherically symmetric alpha boson involves rearranging large amounts of charge density in an extremely short amount of time (10^{-23} seconds, or so) which will give rise, classically, to multipole radiations. The exact character of these multipole radiations can be computed numerically. However it is a laborious calculation and the end result can be gotten to quickly with a single quantum jump

The jump, or rather two jumps, involves the simultaneous jump of each deuteron to its low energy bosonic state. From each jump a photon is emitted of frequency E/h (E = 23.8/2 MeV, h = Planck's Constant; 2.883 x 10^{21} Hertz) which carries away its +1 angular momentum. Note that this can only happen when the two deuterons come together in perfect spin opposition, either with cigar shape ends end-on or side-on. Normally in free space the cigar-shaped ellipsoids would come together with some mutual rotational orbital angular momentum, leading to Oppenheimer-

Philips stripping (what Schwinger called "the asymmetry of the situation"). But the spin-aligning character of the palladium lattice, which has a similar s-d hybrid orbital symmetry to that of the deuteron, allows the deuterons to come together more frequently in a spin-coherent condition. Indeed, if one supposes that the fusion comes about from random deuteron jumps of two deuterons into a vacant octahedral position, the odds are exactly 1 in 6 geometrically that the jump will involve the specific spin opposed deuteron matter wave conditions necessary for D + D = ^{4}He fusion.

Taking away the angular momentum of each spin-opposed deuteron, **the two gamma rays speed away in exactly opposite directions from the center of mass**. We are assuming that each deuteron contributes equally to the Gamow tunnelling energy in terms of its kinetic energy. Therefore the laboratory and center of mass coordinates are identical. The effect of making this assumption is a small error in the trajectories of the emitted gamma rays. Because the two deuterons come together through a tunnelling interaction however, we can assume that the energies of tunnelling are small and that therefore they can be neglected in calculation of the total gamma ray energy. The energy of each gamma is therefore assumed to be 23.8/2 = 11.92 MeV. This is how the quark bag dumps its energy, all at one time: to the radiation field. The same way an electron loses its energy when going from a high energy level to a lower energy level.

The newly-formed hadtonic boson could also decay by the weak interaction, shedding energy into ejected leptons and neutrinos, but this would not be fast enough. Explains Preston [3]:

> *"How then does an excited state of spin zero decay, if there are no other states between it and a zero-spin ground state? It might go by beta decay, forming a different nuclide, but this is a very slow process..."*

Via beta decay and the electroweak interaction, there is not enough interaction time to allow the hadrons of the alpha nucleus to spit out energetic beta rays fast enough in order to lose all its energy. It needs the fast, inertialess reaction time of the Coulomb potential (i.e., the electromagnetic interaction) in order to do it. The production of light in this way is very fitting to the Universe. Note that color temperatures of nuclear matter, in comparison with leptonic matter are enormous in comparison because of the stronger coupling constant (approximately 1 as opposed 1/137) of the Yukawa Potential and because of the much greater amount of mass involved. As in the sun, where the fusion gammas interact with the plasma electrons to shift the peak in the solar blackbody curve to the visible spectral region, an electromagnetic shower process involving thousands of metallic electrons leads to the observed thermal Planck curve for the palladium cathodes involved in excess heat.

PAIR PRODUCTION

Surrounding each fusing D-D and newly formed alpha boson is the vacuum of the lattice. **According to the Dirac model, the vacuum is composed of an infinite number of negative energy states of the electron (the "Dirac sea"), even though to ordinary observations the vacuum seems empty**. Those electrons which are bound with a very great amount of negative energy (an infinite negative energy) can never be freed from their bound state in the vacuum, or at least it is very difficult to do so. However, those electrons which are only loosely bound can be pried loose from their positions near the top of the Dirac sea by the strong polarizing electric field of a gamma ray photon. When a Dirac electron leaves the Dirac sea it leaves a hole behind. This hole is called a positron which can also be thought of as an electron travelling backward in time, although the more conventional view is simply to view it as an anti-matter particle travelling forward in time. The minimum photon energy needed to polarize the vaccum and create an electron-positron pair is equal to twice the rest mass of the electron, or 1.02 MeV. **For reasons not completely understood theoretically, but well-established empirically, the production of pairs by gamma ray photons can only take place in the vicinity of electric charge, for instance in the vicinity of the positive charge of a nucleus**. The pair production process conserves lepton number (1 lepton + 1 anti-lepton = 0), charge (electron (-1) + positron (+1) =0), and lepton spin (+/- 1/2*h-bar + -/+ 1/2*h-bar = 0).

The pair production begins either inside the interior of the nucleus or immediately in the radial region of the resultant alpha boson at distances of between 2.5 fermis and 50 fermis from the fusion-produced alpha boson. The gamma rays do not have to travel far with their tremendous energy before their electric fields rip apart the vacuum and start sending out pairs. Maxwell's equations are obeyed by these circularly polarized gamma rays, with the appearance of a sudden change to the Poynting Vector at the episode of pair production.

It should be noted that the Dirac pair production mechanism is a general one which can also be responsible for the fabrication of muon/anti-muon and pion/anti-pion and other particle/anti-particle pairs out of the "zero point aether", i.e., vacuum. However, in order for a gamma ray to do so, it must have an energy in MeV greater than the rest mass of the particle/anti-particle combination, viz., in the case of the muon, around 2*212*0.511 = 214 MeV. The circularly-polarized 11.92 MeV gammas from the D + D = ^{4}He reaction do not have this much energy. They only have enough energy to produce electron-positron pairs out of the vacuum.

The trajectories of the particles involved in pair production and electromagnetic showers can be calculated numerically from their point of origin in the sub-milli-Angstrom space of the full lattice, albeit in Monte Carlo fashion.

LEPTON SCATTERING IN THE LATTICE

Once the leptons (electrons and positrons) are produced, we can establish a quantitative bookeeping mechanism for keeping track of them and their energy dissipation in the lattice. The passage of charged particles through matter has been rigourously studied for both fast and slow moving charged particles, beginning with the alpha scattering studies of Rutherford in the 1920's. Thankfully, a large volume of analytic equations exist to describe their motions and their interactions with the hadtonic and leptonic matter involved.

As the electron and positron pair travel outward from their birthplace they acquire an arbitrary kinetic energy from the gamma ray and are projected out into the lattice with a fairly homogeneous spread of velocities. Their vectors trace paths which are initially free within the lattice (and completely surprising to the existing leptons in the lattice which travel fixed paths). The leptons may undergo head-on collisions with other leptons or be scattered by the positively-charged nuclei found within the lattice, deuterons, palladium ions, and impurities.

If the electron and positron acquire enough kinetic energy, there is the possibility that they will begin to emit Cerenkov radiation, or Bremmstrahlung radiation i.e., "braking radiation".

POSITRON ANNIHILATION

Eventually a positron will lose enough of its forward velocity so that it is captured by a lattice electron and goes into orbit around it to form a positronium atom. A positron must have lost most of its' forward velocity before it will annihilate because the binding energy of positronium is only, at most, 6.8 eV.

As they spiral in towards each other, they will anhilate at a point. As they get closer and closer, they start to occupy fewer and fewer fractals of space until they are occupying only a few of the fundamental "pixels" of the space-time fabric. These pixels of space-time are of the same linear dimensions as the Planck Length (i.e., 10^{-30} cm) and wink in and out of existence periodically in a Heisenberg way. In a reverse of their birthing process, the particle and anti-particle matter waves are winked out of existence right back into the vacuum.

Again the collapse is so sudden that the inertia-less response time of the Coulomb Field is needed to balance the energy conservation law. Gamma radiation is emitted from the annihilation region. However, since the two particles are fermions, they each carry the angular moment of spin 1/2*ħ. There is thus the angular momentum to get rid of as well. Racah algebra tells us that the way to get rid of the angular momentum is to have the electromagnetic field carry this angular momentum away. In a parallel process to the alpha boson condensation process, two oppositely circularized photons each carry away 1/2*ħ of angular momentum away. The energy of each of the annihilation quanta is thus 511,000 electron-volts.

Some positrons may be annihilated in the so-called "in flight" mode. This happens in the unlikely event that a positron in flight collides head on with an electron whose spin at the moment of contact is exactly opposing the positrons. (This in fact is almost the same low probability that one has outside the palladium lattice that two deuterons will collide with their spins opposed in a hot fusion.)

WHAT HAPPENS TO THE ANNIHILATION RADIATION

As opposed to the prompt circularly-polarized gammas from the quark bag transfer and collapse which have initially too high an energy to be effectively scattered by the matter of the lattice, (they interact with the Dirac vacuum instead before being spent down to a small fraction of their initial energy), the 511,000 volt x-rays of anhilation are low enough in energy to exhibit marked Compton, Rayleigh, and Raman scattering inside the lattice. The maximum energy which a photon of energy h*v can give to a particle of mass M in an elastic Compton scattering event is:

$$E_{max} = (2/(2 + M^*c^2/h^*v))^*h^*v$$

where M = Rest Mass of Charged Particle (MeV)
c = Velocity of Light
h = Planck Constant
v = Frequency of Gamma Ray (Hz)

The 511,000 electron-volt anhilation X-rays can thus lose about 0.001% of their energy in each collision with a palladium nucleus, 0.05% of their energy in each collision with a deuteron, and 67% of their energy in each collision with an electron. In all cases, the Compton collision acts to give recoil velocity to the matter particle and to lengthen the wavelength of the scattered X-ray. The gamma ray may be Compton scattered many times in succession of course and so it appears that the gamma ray is in a continuous process of losing energy as it travels through the lattice. Within what is defined as a "scattering length", L(o), the energy of the gamma ray will be down by a factor of 1/e. In palladium-electrolyte-glass-H_2O bath setting, the scattering length is modified by all materials to about 1.4 centimeters [4].

In the cases of Compton collisions with hadrons, the recoil velocities of the nuclei are negligible and may be cushioned by a Mossbauer-like effect, coupling the inertia of the ion into the inertia of the lattice as a whole. This is especially the case with palladium nuclei. It is more difficult to make this case for the deuterons as the deuterons escape with 255 electron-volts of energy. But in the case of the electrons, they can indeed acquire significant recoil velocity. If we assume that 100% of the Compton collision energy is imparted to the electron's velocity, then the electron will fly off with a highly relativistic speed which will cause it to emit continuum Cerenkov radiation into the lattice, which itself will be Compton, Rayleigh and Raman scattered, largely into lower and lower wavelengths (i.e., heat). There is some up conversion from the anti-Stokes shifting by scattering against high energy phonons, but this effect is small, relatively speaking. Thus the net effect of this X-ray/relativistic electron scattering process is to generate heat quite rapidly and, presumably, to contribute to the characteristic nebula-like "fogging" patterns seen in CF autoradiographs.

Note the annihilation gammas and many of their longer-wavelength Compton-scattered derivatives have enough energy to completely disrupt the inner shell electrons of the palladium ions in the lattice, knocking them completely out of their orbits and into the conduction band and beyond. When an electron does not exhibit normal k-vector Bloch wave behaviour it is said to be "out of the conduction band" and exhibits "anomalous dispersion." Anomalous is the right word. Unlike other "normal" electrons in the metal, an ejected electron's trajectory does not fit a nice periodic Bloch function which can be composed out of the primitive vectors of the Fermi Surface. And the hole it leaves behind also creates new disturbing motion in the electron sea. Other nearby conduction band electrons have an opportunity to fall into this potential well and in so doing release even more visible, ultraviolet, and X-ray light into the lattice where it is quickly down-converted incoherently into the infrared spectral region by collisions with lattice electrons, ions, and acoustic vibrations.

At all times the disruption of the electron distribution inside the lattice is subjected to "healing", that is the rapid replacement of damaged covalent and electrostatic bonds with fresh electron "glue", electrons which are able to jump down into any potential wells, however large or small, which show up as the condition of the lattice evolves.

The electromagnetic jet process is depicted in Fig. 1. Characteristically, one or a few particles impart their energy to a multitude in short time in a non-self-sustaining chain reaction.

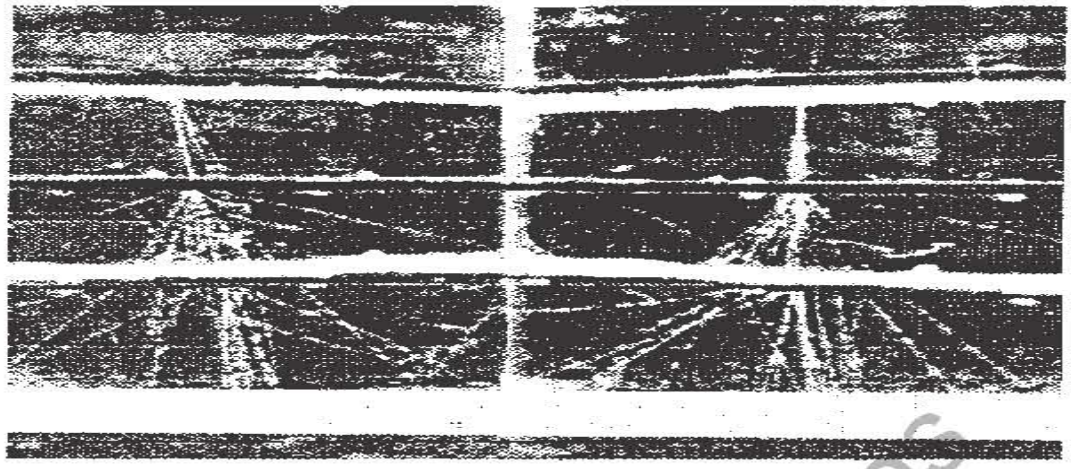

Fig. 1 Electromagnetic shower evolving from top to bottom within a series of four lead plates, spaced approximately 0.2 cm apart in a Wilson cloud chamber. (From Nuclear and Particle Physics, W.S.C. Williams, Oxford Scientific Pub., Clarendon Press, Oxford, 1991.)

INTERNAL CONVERSION ELECTRONS

The heat production process described above is complete qualitatively except for one other process. Besides intitial energy loss by twin gamma ray, and in addition to it, there is also the possibility that internal conversion electrons can be produced. This is the so-called internal conversion branch for this process. This starts when an orbitting lattice electron may be in the vicinity of the nucleus when the quark bag collapse occurs. If this is true, then the electron can be perturbed out of its normal orbit and accelerated out from the nucleus. The energy imparted to this electron can be arbitarily high (up to the 23.8 MeV binding energy), depending on how close the impact is between the point charge of the nucleus and the electron. The electron can then be ejected at relativistic speeds. If we assume that a single electron carries away all the energy of fusion, its initial relativistic "beta" velocity would be 0.99977 c.

An electron travelling at this high a velocity would soon emit a high energy Cerenkov photon with an energy above the 1.02 MeV threshold for Dirac pair production. The vertex coupling constant for the Cerenkov interaction can be calculated using QED and the trajectories of the emitted particles can be followed in Monte Carlo fashion.

The internal conversion mechanism proceeds as it is normally thought to occur in nuclear matter, as an interaction between atomic electrons, largely *s* electrons, and the nuclear charge distribution, quarks included. Such interactions can either occur inside or outside the quark bag which was mentioned earlier. The internal conversion process involves primarily atomic 1 *s* electrons. However, to the degree that their are two 1 *s* electrons (hydride ion) involved in the resonant state system, and to the degree that other orbitals (2s, 3s, etc.) spend time near the nucleus, they can all participate. In this case the ejection energy is distributed over more than one electron. These multiple events are of course increasing less likely than single electron conversion.

There are two regions where the internal conversion mechanism can take place (1) in the vacuum outside the nuclear surface; and (2) inside the nucleus itself when the quark bag is rearranginging. The latter type of interactions which may involve electron collisions with individual partons, are called "nuclear matter" conversion electrons. It should be noted that if lattice electrons are indeed acting to screen the repulsive positive charges of two deuterons which are coming together for fusion, they will be more likely to be found in the region of space between the two deuterons. Therefore, the internal conversion branch may be preferentially enhanced in a lattice environment.

The di-neutron mechanism proposed by Chuan-Zan Yu, and Yi-Fang Chang at the Dept. of Physics, Yunnan University, Kunming [5] appears incorrect since it posits an intermediate state between the two deuteons and the alpha boson which involves a spontaneously created nuclear electron. Since electrons are leptons and can only be

produced from hadronic matter via the (slow) weak interaction, it is incorrect to include an electron in the proposed nuclear particle stoichiometry. It is equally incorrect to posit as an intermediate particle-state the ^{2}He nucleus since: (a) this particle has never been seen to exist in Nature, and b) the raw Coulomb force unmediated by a neutron "glue" in this nucleus would make such a physical state unviable. While an atomic electron may be involved in traditional internal conversion, it cannot be involved by simply "appearing" to offer charge balance with an imaginary ^{2}He nucleus. The authors' concept also violates another fundamental tenet of hadron physics which is conservation of baryon number. Pair production and internal conversion are the only two ways to get electrons quickly out of the re-assemblage of hadronic matter.

SUMMARY

A process has been described which qualitatively defines the energy release pathway of newly-formed alpha bosons in a metallic hydride lattice. The simple picture obtained for the energy release mechanism alleviates the necessity of observing hard 23.8 MeV gammas before believing that the anomalous effects which are occuring in deuterated palladium lattices can be occurring from D + D = ^{4}He fusion. The theory suggests the possibility of a quantitative bookkeeping method for keeping track of the fusion product energies which are heating the lattice. X-rays have been reported by several laboratories at quite different energies. [6,7] It also suggests several viable experiments which would help reveal the workings of internal energy conversion mechanisms.

There should be appreciable amounts of 0.511 MeV circularly polarized gammas emanating from the experiment, despite the loss of many in electromagnetic showers inside the cathode and surrounding environment. An examination of the angular distribution of these gamma rays and of their polarizations would help to reveal much about the interior workings of the fusion process.

There is nothing unusual about main mechanism necessitated for lattice (and calorimetric bath!) heating by this explanation, i.e., the electromagnetic shower model, from the point of view of conventional physics. The production of transverse lepton/anti-lepton jets (electromagnetic showers) from hadron-anti-hadron collisions is a well-known feature of high energy physics. The characteristics of those jets provides a way to elucidate the parton structure functions inside the hadrons themselves and is an important part of "conventional" hadron spectroscopy.

The Drell-Yan model of leptonic production presupposes an intermediate vector boson which leads to leptonic pair production in high energy collisions in the same way that the two prompt gammas (themselves vector bosons) from the D + D = ^{4}He fusion reaction create electron-positron pairs out of the Dirac vacuum. A single 23.8 MeV gamma ray has dipole parity and can only exist in a virtual state. As such it might function as a Drell-Yan vector boson, leading immediately to the production of a high-energy electron-positron pair out of the vacuum. However, the 23.8 MeV gamma would never actually be observed. The work of Barnes et al. [8] and Fowler [9] needs to be referenced in this regard as they claim that the 23.8 MeV gamma ray is in fact seen in d + d ion beam smash reactions. But the experimental data Barnes presents for the 23.8 MeV signal is a little hill in the gamma ray spectrum, only a little bit above cosmic ray noise. They fail to show confidence intervals or give us details on the statistics of the data distribution. Furthermore, the signal at 11 - 12 MeV on their graph is completely obscured by the numerous amounts of gamma rays resulting from neutron capture reactions in the NaI scintillation crystal so there is no way to see what the two-photon signal from the reaction might be, or what the helicities of these photons would be. Since the noise problem appears to be a generic one with this fusion system using NaI detectors, it would appear that other researchers using this same all-purpose detector would have the same trouble identifying the 11.9235 MeV gammas. Thus the claim of Fowler that this is a well-studied area seem to me to be overstretching. Fowler's, relative cross section calculations are based on highly-asymmetric spin-incoherent conditions which are not present in the palladium quantum lattice. Furthermore, his calculations and the calculations of others [10] who rely on the 23.8 MeV gamma ray signal data, necessitate attributing some d-orbital character to the matter wave (and therefore to the charge distribution) of the alpha boson. Since the measured electric quadrapole moment of ^{4}He is known to be zero, this seems speculative.

The two gamma ray energy release mechanism (and also the energy release of single or multiple internal conversion electrons) can only be described qualitatively, or rather semi-quantitatively, at this point because the equations which are needed to accurately describe the electromagnetic coupling which occurs between the constituents of the individual quark bags when they are rapidly reassembling are unknown. Clearly the only correct explanation can

come from a detailed examination of the energy and momentum changes which are experienced by the individual quarks when the quark orbits are allowed to collapse to bosonic form and the possible coherence effects which may exist between the different quantum states.

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DEFINITIONS OF POWER AMPLIFICATION FACTOR USED TO DESCRIBE ENTHALPY PRODUCTION

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ABSTRACT

In enthalpy producing systems, the power amplification factor is the ratio of the applied input power to the heat (enthalpy) actually generated. An accurate definition for this factor influences the amount of putative "excess heat (enthalpy)" in such energy experiments, yet it remains not completely resolved. Because of the recombination issue and the reasonable initial skepticism towards the possible existence of solid state fusion systems, and to achieve some uniformity and simplicity, it is recommended that the absolute (minimum) power amplification factor should be used - or at least included - in the description of any putative excess enthalpy experiment.

INTRODUCTION

Excess heat has been reported in scientific literature describing a plethora of solid state fusion experiments [1,2]. However, several hurdles remain both for the successful utilization of the cold fusion (or other hydrogen energy) phenomena and for improved communications describing these experiments. Specifically, in addition to problems related to the obtainment and characterization of materials of sufficient purity and integrity into which to successfully load [3,4], activate [5,6] and optimal drive [7], the isotopic fuel, even the exact definition of the amount of putative "excess heat" (thereby implying "excess energy") actually produced remains only partially resolved. This paper addresses most of the definitions of power amplification factor which relates the applied (input) electrical power into a device such as an electrochemical cell, to the observed excess heat which is actually generated. The issues discussed include the electrical polarizations which necessarily result from electrical conduction [8] and then provide the possibility of electrical energy storage, and the mass (gas) transfer from the solution at the electrodes which also may spatially impede the electrical conduction, yet increase the electrochemical cell's thermal conductance thruput.

CLASSICAL ELECTRODYNAMIC SYSTEMS

In electrical systems, the rate of input energy dissipated (input electric power; P_i), and the input energy (E_i), are defined as the product of the applied electrical current and voltage [defined as -1*the electric potential(Φ)], and their time integral. The flow of energy, according to classical electromagnetic theory, follows the Poynting vector [9,10] as discussed in physics and electrical (power) engineering.

$$P_i = V*I \ \text{[watts]} \tag{1}$$

$$E_i = \int_0^{\Delta T} [I(t) * V(t)]\, dt \ \text{[joules]} \tag{2}$$

However, power calculations are more complicated for several reasons. First, in such linear time-invariant analysis, all frequencies, including noise components [11] and not only the DC component, must be considered. Second, there is, or may have been, energy storage supplementing the expected simple energy dissipation. Third, such calculations are linked to material aspects involved because such possible energy storage can and will occur both at those sites and between those sites (e.g. the electrical double layer in front of the cathode). Fourth, the energy dissipated (the electrical power) depends not only upon the actual dielectrics, electrolyte, and metals and their contacts, but also depends upon the generated eventual redistribution of all polarizable materials (such as ions in the electrolyte) and even the gases which are formed in front of the electrodes.

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INCLUSION OF ENERGY STORAGE IN MATERIALS COMPRISING THE SYSTEM

One may obtain a bulk electrical resistance from the electrical power dissipated. What is usually done is to simply derive the electrical conductivity (σ) for the electrolyte (a dielectric as distinguished from the metal electrode). By dividing out the volumetric term (L*A), there results the definition of the rate of energy dissipation per unit volume (watts per cm^3).

$$P \approx \frac{V^2}{R} \text{ (watts)} \tag{3}$$

$$R = \frac{L}{\sigma * A} \text{ (ohms)} \tag{4}$$

The inclusion of energy storage can be considered and explicitly added by switching to complex terms, containing real and imaginary components. Now although this is only an approximation, and the materials may be neither isotropic nor homogeneous, it does yield the definition of a complex permittivity describing the electrolyte material which has been widely and successfully used [8]. This conversion can be handled for the enthalpic heating literature by separation of variables. For this approximation, the conductivity is the imaginary term of a more complex permittivity, ε^*, which describes the electrolyte (and each of the other materials). The complex permittivity actually links the various electrical conduction and polarization mechanisms, and is described mathematically as

$$\varepsilon * = \varepsilon' - j\varepsilon'' \tag{5}$$

In the non-DC regime, the normalized rate of energy dissipation (power density) must include the entire sinusoidal Fourier series. But what do these real and imaginary components of the complex permittivity, ε^*, physically represent? The electrical conductivity is linearly related to the imaginary portion of the complex permittivity. Both ε' and ε'' vary over frequency (ϖ), and themselves are inexorably linked in Hilbert Space because each mechanism of conduction produces — as a result of the conduction — some degree of electrical polarization.

$$\sigma = \varpi * \varepsilon'' \quad (1/\text{ohm-cm}) \tag{6}$$

The first term of the complex permittivity, it's real component (ε'), is related to the more well-known dielectric constant (κ') through the free-space (vacuum) permittivity (ε_0), as well as to the more familiar index of refraction (n).

$$\kappa' = \frac{\varepsilon'}{\varepsilon_0} = n^2 \tag{7}$$

Finally, as is done in power engineering and physics, the definition of the loss tangent then relates the rates of electrical energy dissipation to the storage of electric energy by a simple ratio.

$$\tan \delta = \frac{\varepsilon''}{\varepsilon'} = \frac{loss\ current}{charging\ current} \tag{8}$$

However, this is where complete agreement regarding the matter of energy transfer appears to end. The physics that describe these processes [3,6-8,12,15] is complicated and the thermal issues involve radiation, conduction and convection terms. Although the physicist, power, radio, and system engineer are in agreement even though using slightly different descriptions of energy and matter to this point, it is where the energy and mass transport with entry to the gas phase that complications in the definitions energy and energy transfer begin to separate.

DYNAMIC RESPONSE OF AN ELECTROSTATIC SYSTEM

After application of the voltage, there is produced between the electrodes an applied electric field intensity and the system responds thereby altering that initial applied electric field [8,16,17]. These responses ("polarizations") include

activation polarization at the electrode, concentration polarization at the double layers vicinal to the electrodes, and the IR polarization ("voltage drop") in the solution [16]. If the IR drop dominates, and if the local magnetic field intensities are not time-varying, then Kirchoff's voltage law does hold. The power dissipated may be generally approximated as initially being across the dielectric in a conventional electrolytic system. Initially, and prior to the dielectric relaxation time, the electric field intensity is the applied voltage (minus contact and double layer potentials) divided by the gap between the electrodes and is distributed across the solution. The polarization will eventually alter the electric field distribution and this must be considered. Furthermore, these materials are inhomogeneous, time-variant, nonlinear, probably not isotropic, and also concerning not only the solution and electrodes but the barriers as well.

In many solution calorimetric experiments [7,12,18-21], beyond the scope of this note, the thermal output power (P_{out}) and energies are derived from complex dynamic temperature measurements generally involving isoperibolic or flow systems, and in some of those the thermoneutral potential is included. With the use of electrochemical systems, gas phase reactions at metal electrode surfaces arise which create low dielectric constant layers (bubbles) at that site [10]. The impact is the following. First, the addition of classical electrochemistry [16] to the power engineering equations usually requires an assumption of thermodynamic equilibrium, which may not actually be achieved in these reactions [3,7,16,17]. Second, although the equations above account for both energy loss and storage, they do not include reduction of the applied transsample potential by the thermoneutral potential (1.48 volts for light water). This results in several distince definitions.

THE POWER AMPLIFICATION FACTOR

Given the above complexities, one must begin with the most fundamental of definitions. The most accurate definition of both the absolute power factor and the incremental power of such systems are derived from P_{out} (the output power in watts) and P_{in}. The power amplification factor Π is nondimensional, and is defined as P_{out}/P_{in}. The definition requires that the factor is measured for times longer than energy storage could persist. The incremental excess power (= P_x ;[watts]) is defined and derived as $P_{out} - P_{in}$.

$$\Pi = \frac{P_{out}}{P_{in}} \text{ (watts)} \tag{9}$$

This simple definition of the power amplification factor will now also be specified as the "minimum power amplification factor," because each of the other definitions, considered below, actually generate numerically larger values for the identical measured data. It is these other, larger, less precise definitions of "Π" where some of the major complications in the field arise. The following are the corrections generally used in the field to account for the gases and energy storage processes.

MODIFICATION FOR GAS PHASE GENERATED - THERMONEUTRAL POTENTIAL

The thermoneutral potential is based upon the standard free enthalpy of water and is 1.48 volts (light water, 1.54 for heavy water) which is that applied electrical potential which produces gas evolution at the cathode without any incremental temperature change at that location. Although the standard free energy of water yields a theoretical decomposition voltage of water of 1.23 volts [16], it is the "thermoneutral potential" (V_{therm}) which is subtracted from the cell voltage [7,12,16,18] to derive the non-gas-producing electrochemical "input power." By this method, the voltage used in the calculation is modified to $V_{cell} - V_{therm}$.

$$\Pi_2 = \frac{P_{out}}{P_{in} - (V_{therm} * I)} \text{ (watts)} \tag{10}$$

Although much of the calorimetry in the field is directed towards utilization of the thermoneutral potential, it is simply not respected universally unless explicitly declared, and the system may not be isothermal at the electrode interface. Furthermore, the utilization of the thermoneutral potential does create, even if by an inadvertent link, a requirement to examine the rate of gas recombination (to form pH 7 water from H_2 and O_2 possibly at some distance from the cell) more closely. The other major reasons against this definition include the possible absence of a

thermodynamic equilibrium and the use of this number (V_{cell} - V_{therm}) in a ratio where the difference is located in the denominator possibly yielding a potential singularity.

MODIFICATION FOR GAS PHASE GENERATED - GAS STREAM ENTHALPIC LOSS

Recently a correction for the power amplification factor involving a numerator term has appeared [22,23] which is yet another alternative definition. This derivation involves augmenting the numerator by a term which accounts for the excess power transfer to the gas stream from the electrochemical cell. This increase loss of enthalpy to the gas phase does occur during electrolysis, and not during the control electrical heating resistor calibration cycle, for several reasons. There is energy removed when the water leaves the cell in open systems, and furthermore, the generation of hydrogen gas leads to increased thermal conductance. These both may lead to significant unintentional loss of heat out of the electrochemical cell in open systems. As a result, calculations may underestimate the actual outputs in such systems during electrolysis. Therefore, another definition is less frequently used.

$$\Pi_3 = \frac{P_{out} + (V_{therm} * I)}{P_{in}} \text{ (watts)} \qquad (11)$$

This alternate derivation of the power amplification factor is not identical to either the denominator corrected power amplification factor or absolute power amplification factor. The significant quantitative differences in these definitions is shown in Fig. 1 for four efficiencies of power amplification and varying input power levels. The minimal power amplification factors are the solid horizontal lines in Fig. 1. The alternate derivations are the dashed lines and the lines interspersed with "squares." It can be seen that there can be significant differences in the derived values at relatively low input drive levels.

Additional confusion results from a diverse literature with further definitions, albeit much less frequent in appearance. Some of these have even been defined directly by delta-T's of the experiments [24].

SUMMARY - INCLUDE MINIMAL POWER AMPLIFICATION FACTOR

In summary, the amount of putative excess heat in some experiments remains ambiguous because the definition of the power amplification factor is unresolved. Such ambiguity results because of issues of recombination and attempts to compensate both for gas generation and flow. These factors interact to produce several distinct competing "definitions" of the power amplification factor. Just as it is important to separate power from energy because storage can create false positives of "excess heat", it is also important to choose a universal definition to support energetic computations. Because of the several competing, distinctly different, "definitions" of the power amplification factor, because of the recombination issue, because of the erroneous skepticism towards solid-state fusion and other hydrogen energy systems, and because of the importance of providing uniformity and simplicity, it is recommended that the absolute (minimum) power amplification factor (Π) be used, or at least included, to describe the result of such experiments.

TABLE OF SYMBOLS

ΔT Increment of Time	seconds	P_{in}	Input Power (= V*I)	watts
E Energy	joules	$P_{out} - P_{in}$	Incremental Power	watts
I Electrical Current	ampere	P_{out} / P_{in}	Power Amplification	nondimensional
Π Power Amplification Factor	nondimensional	t	Time	seconds
Π_{abs} Absolute Power Amplification Factor	nondimensional	V	Voltage = – the Potential	volts
Π_2 Power Amplification Factor corrected for gas flow using denominator	nondimensional	V_{cell}	Potential across cell	volts
Π_3 Power Amplification Factor corrected for gas flow through numerator	nondimensional			

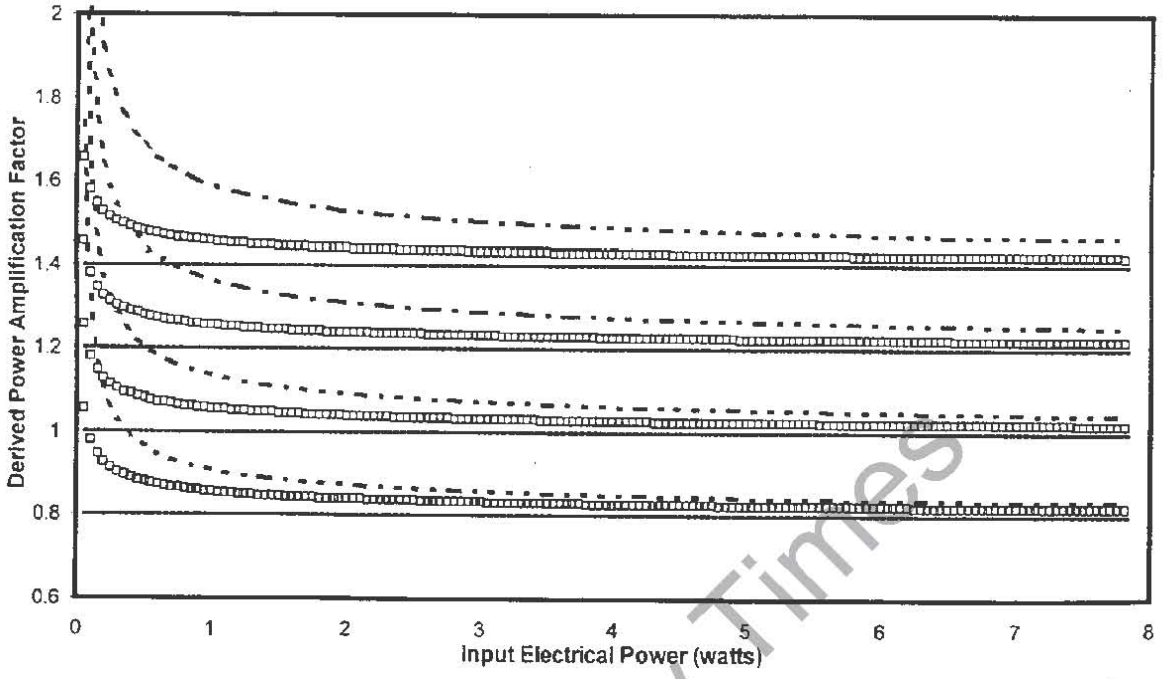

Fig. 1 - Three Definitions of Power Amplification Factor
These twelve curves demonstrate the impact of three definitions of the power amplification factor. Four different absolute power ratios are shown (0.8, 1.0, 1.2, and 1.4), where the 1.4 power amplification factor represents a gain of 140%, and is "overunity." The 1.0 power amplification factor level is "break-even". The calculated values of the "power ratio" are shown for varying amounts of electrical input power. The input is 3 volts and the solution resistance is 150 ohms.

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SPACE ENERGY

USE OF ASYMMETRICAL REGAUGING AND MULTIVALUED POTENTIALS TO ACHIEVE OVERUNITY ELECTROMAGNETIC ENGINES

T.E. Bearden

ABSTRACT

Asymmetrical regauging and multivalued potentials (MVPs) occur widely in nature and may involve fields that are nonconservative, i.e., the free production of excess force fields. Yet conventional electric and magnetic engines are designed with gauge frozen and utilizing conservative fields and single-valued potentials. Self-induced change of potential, as by an MVP, can be utilized to accomplish *asymmetrical self-regauging* (ASR) (A-regauging) of the engine's stored energy at a certain point or sector. This is equivalent to free "refueling" of the engine, at each regauging position in its cycle, with excess energy furnished from the vacuum. During asymmetrical regauging, the system is an open system receiving excess energy from a known external source, so it can exhibit a COP>1.0 without violating the laws of physics. One or more additional force fields will appear, and they may be used to assist the operation of the system, by deliberate design.

When Maxwell's equations are expressed in (A, ϕ) form, two equations result in which A and ϕ are coupled and the variables are not separated. Electrodynamicists then *arbitrarily* alter these equations by making two simultaneous asymmetrical regaugings, designed so that the net regauging is symmetrical -- i.e., the net force fields are unchanged. The variables are separated by this *net symmetrical* transformation. These regauged Maxwell equations are then widely utilized in the literature, without further regauging. The *net symmetry* of the overall regauging *curtails and closes Maxwell's EM model and the operation of any designed Maxwellian system to further regauging, particularly asymmetrical self-regauging*. In short, it eliminates the system's permissible *free collection and use* of potential energy from the external environment (i.e., the vacuum), by asymmetrical self-regauging.[1]

Yet, engine designers ***are*** free to deliberately utilize asymmetrical self-regauging (ASR) (A-regauging) in their engines, in which case free collection of excess energy from the vacuum -- and its use in the engine -- is permitted, and over-unity engines result. Usually only a single potential need be the focus of the A-regauging -- so long as the accompanying free force (a) does no work upon the system and is thus nullified, or (b) independently does useful work upon the system to increase its energy, or (c) reverses the back-emf or back-drag force that would otherwise reduce the energy of the system. For the latter case, the net extra force is also deliberately used to *assist* the system's operation rather than hamper it.

Three specific self-initiated, asymmetrical regauging over-unity engines are presented as examples and their operation explained. Since these engines are experimentally confirmed to provide COP>1.0, then electrodynamicists must abandon their arbitrary, self-imposed limitation to only *net symmetrical* regauging in classical electrodynamics and in electromagnetic engines.

INTRODUCTION

Recently three developments of note have become important in research for over-unity electromagnetic engines. These are (a) the Johnson magnetic propulsion gate [1], (b) the magnetic Wankel engine [2], and (c) the Kawai engine [3]. The over-unity operation of the propulsion mechanism for these devices has aroused considerable controversy among scientists and engineers, who have begun to debate them with vigor. Yet none of the debating

[1]We take the view that any over-unity system must be an open system freely receiving excess energy from an external source, so that non-equilibrium rather than equilibrium thermodynamics applies. As is well-known, such a system can permissibly exhibit a coefficient of performance greater than unity, and there is no violation of conservation of energy, the laws of physics, or the laws of thermodynamics.

scientists and engineers seem to have grasped the principles of operation that are employed by these devices in order to permissibly achieve a coefficient of performance (COP) greater than unity.

Also, little of the debate so far has addressed the primary over-unity issues as follows:

(a) In any over-unity EM engine, some part of its operation must violate the *conventional* classical electromagnetics (CEM) model, since CEM prohibits over-unity operation within its "closed system" modeling description.

(b) Since the three engines being discussed all utilize CEM concepts and not exotic thermodynamic processes, then meticulous attention must be focused upon the CEM model itself. The devices are *experimentally* verified; hence one must re-examine the "closed system" EM theory *with a view toward how the system is opened by these proven systems and excess energy received from the vacuum.* In short, whatever closed the CEM model in the first place, must be re-examined and modified to permit deliberate reopening of the model.

(c) To date, technical arguments raised against the devices all resort to the use of conservative fields and single-valued potentials, when in fact it is well-known that multivalued potentials and nonconservative fields easily arise, particularly in magnetics where they are often the rule rather than the exception. But this concept immediately impels us into gauge theory, and to the notion that in some fashion *asymmetrical* self-regauging -- which can freely change the potential (collected) EM energy of the system -- must be self-induced in the engine.

(d) Broken symmetry in a system is required for its over-unity operation; i.e., the system must be an open system receiving excess energy from outside, so that nonequilibrium rather than equilibrium thermodynamics applies. Otherwise, the first and second laws of equilibrium thermodynamics rigorously exclude any such over-unity operation. In other words, any over-unity EM engine must perform some operation exclusive of equilibrium thermodynamics, and therefore included in non-equilibrium thermodynamics.

(e) Since the *net* regauging of Maxwell's equations conventionally utilized by electrodynamicists is *symmetrical* (i.e., the changes in the force fields counter each other so that only the potentials are changed), net broken symmetry does not occur and equilibrium thermodynamics (ET) applies. But ET is already violated by the experimental demonstration of over-unity. Hence *asymmetrical* regauging must apply. The electrodynamicists' *net symmetrical* regauging actually employs *two simultaneous asymmetrical* regaugings, specifically selected so as to (i) separate the variables, and (ii) vector sum-zero the individual force fields resulting from the each individual asymmetrical regauging. The requirement therefore emerges that this exact "net symmetrical" regauging operation must be violated.

(f) The *net* regauging performed in the actual over-unity system must be *asymmetrical*; i.e., its force fields *must* change as a result of its regauging, and in such fashion that the net work these excess force fields subsequently perform upon the system increases its energy and enhances its operation. In rotary EM engines, "asymmetrical regauging of potentials" is analogous to an automobile taking on or jettisoning fuel. The production of associated excess forces formed by the regauging, which then perform work on the system, is analogous to "burning the fuel to do work and power the system." When the excess force performs work, it drains (dissipates) its associated potential, just as burning the fuel empties the fuel tank.

(g) Skeptics do not seem to realize that the *potentials*, not the force fields, are already known to be the primary causes of all EM phenomena, and that the force fields are already known to be effects produced only in and on physical matter [4,5]. *There are no force fields in vacuum, contrary to CEM*, as is well-known in the foundations of physics [6]. Instead, there are only potentials and potential gradients. Further, all EM potentials are already net changes to the background vacuum potential. Ultimately any system collection of excess energy from the outside vacuum must first come through a change of system potentials,[2] which then couple to the matter in the system to create force fields as effects in the material system. These force fields only become causative agents *once they are formed in and on the physical matter.* Hence *a priori* an over-unity EM engine operationally must vary from the conventional CEM interpretation which focuses only on the force fields. Instead, one must focus attention upon (i) the potentials as the primary mechanisms enabling the violation of conventional CEM, (ii) the free intake of excess energy from the vacuum via the altered (regauged) potentials in the form of asymmetrical self-regauging, and (iii) enabling "free" formation of excess force fields which then do useful work on the engine to increase its kinetic energy.[3]

[2] Which are simply *the most adjacent coupling aspect of the local vacuum.*

[3] Here we are assuming rotary EM engines.

(h) Close attention to the potentials in CEM theory reveals that CEM in (A, ϕ) form has already been artificially *regauged* by the electrodynamicists and modified to separate the variables for ease of calculation [7]. This *net symmetrical* regauging has also frozen the gauge. Asymmetrical regauging is in fact permissible; and when it is also considered, the present "gauge-frozen" CEM becomes only a *subset* of the full "regaugeable "CEM that is inherent in the (A, ϕ) form of Maxwell's equations *before* the A and ϕ variables are decoupled by net symmetrical regauging, and *before* the CEM gauge is arbitrarily frozen. We proceed now to address these issues [8].

GAUGE TRANSFORMATIONS AND GAUGE SYMMETRY

First we advance the usual definitions and then modify them so as to permit full regauging, either symmetrical or asymmetrical.

A *gauge transformation* in electromagnetics is conventionally taken to be the addition of the gradient of some function of space and time to the magnetic vector potential -- *and simultaneously* the addition of the negative of the partial derivative of the same function with respect to time, divided by the speed of light, to the electric scalar potential. This procedure gives different potentials but leaves the electric and magnetic fields unchanged [9]. In short, it has restricted gauge transformation to *net symmetrical* gauge transformation.

Gauge symmetry is the abstract mathematical symmetry of a field related to the freedom to re-gauge, or re-scale, certain quantities in the theory (potentials) without affecting the values of the observable field quantities [10]. Again, this "standard definition" restricts the gauge transformation to a *net symmetrical* transformation -- and thus restricts the *sum of a series of such transformations* to a net symmetrical transformation.

A *gauge theory* is a field theory based on the use of a field that possesses one or more gauge symmetries [11]. Here again is the *net symmetrical regauging* restriction. Electromagnetics was the first gauge theory. Gauge theory is widely utilized in particle physics, accounting for the Standard Theory by which all other competing theories are judged [12].

We, therefore, extend this *symmetrical* limitation of gauge theory and include the notion of *asymmetrical* or *partial* gauge transformation, where the fields may change but only in such fashion that they cannot perform *hampering* work on the system.[4] By our definition, the extra forces that are created may, of course, perform *assisting* work on the system, or they are free to add to and vectorially cancel or reverse some particular back-emf or back-drag force that is normally produced and that would otherwise hamper the system operation, or they are free to be "bottled up" and just do nothing. **Hereinafter we shall use the terms "regauging" and "self-regauging" so as to automatically include either *symmetrical* or *asymmetrical* regauging, and to include *self*-regauging as well as *externally-induced* regauging.**[5]

The foregoing extended definitions tell us that in electromagnetics one can appropriately change *(regauge)* the scalar potential and the magnetic vector potential, *and* thereby freely create changes in the force fields themselves in a manner that lets the excess forces do work on the system to increase its energy [13].[6] Indeed, an electromagnetic engine can be so designed that it performs the regauging function *automatically*, and this *self*-regauging asymmetrically creates new force fields that help the operation of the system. In other words, by an **asymmetrical**

[4]Note that we are deliberately excluding the class of asymmetrical regaugings where the excess forces produced will hamper the system operation rather than enhance it. The system designer of the *over-unity* engine is actually required to design the engine in accordance with this exclusion.

[5]When one "energetically powers" the conventional system by applying brute force methods to re-energize it, one is actually asymmetrically regauging the system by "brute force" externally-induced methods. Now one perceives how very crude and barbarous have been all our previous major power systems -- such systems as wind mills, the sail, solar cells, and water wheels being notable exceptions.

[6]Note that we have restricted the force fields to changing only in a *helpful* fashion. For such asymmetrical regauging purposes, in electrical circuits it is better to replace the (A, ϕ) representation of Maxwell's equations by a representation using *two scalar potentials only*, as shown by Whittaker, Debye, and Nisbet [13].

self-regauging (ASR), a change of the potentials and concomitant appearance of one or more helpful extra force fields can be accomplished "work free," by the engine itself, as part of its normal operation. The helpful **extra fields** produced are free to perform work to increase the energy of the system, via our definition. By employing such deliberate ASR, the system can operationally increase its collected potential energy by design, and also its kinetic energy, without any outside work being performed upon that system in the usual sense.[7] By continually self-regauging asymmetrically to freely increase its energy, the system will continually and freely "refuel" itself with an influx of excess EM energy directly from the surrounding vacuum. It will dissipate this excess energy by translation of the associated excess forces produced by the regauging, in such manner as to increase the kinetic energy of the system (rotary engines assumed). *A priori* such a system is capable of COP>1.0.

We accent that increasing the potential of a system, or allowing a "freely appearing" force to do work upon the system to increase its kinetic energy, or both, automatically changes the stored energy of the system. If at least one of the altered potentials in a regauged system is *increased*, that "recharged" part of the system takes on and stores excess energy, *initially* without involving the force fields **E** and **B**. But to **use** it, one must transform the collected excess energy into excess force fields that translate and perform work on the system to change the form of the energy from **potential energy** to kinetic energy.[8] Therefore the self-regauging must be *asymmetrical*. If an excess **E** or **B** field is produced and does work to increase the system's kinetic energy, this results in stored excess energy in easily usable form. The excess kinetic energy resulting from the asymmetrical regauging can then be judiciously discharged to power the load, so that the system returns (regauges asymmetrically and detrimentally) back to its starting or initial condition, powering the load in the process. Then the system must be asymmetrically **regauged** once again in the **charging** mode, to accept and store some additional excess energy. And so on.

A-regauging the potential(s) of the system can be compared to refueling an automobile, except that electromagnetic potential self-regauging can occur **for free** if the system designer deliberately designs the system to do it.

Obviously, *asymmetrically self-regauging its potential(s)* and usefully employing the excess force fields is one of the master principles of an over-unity electromagnetic device or engine.

THE TECHNICAL BASIS OF REGAUGING MAXWELL'S EQUATIONS

For A-regauging considerations, we are speaking of A-regauging the Poynting energy flow in a circuit.[9] This means

[7]We most strongly stress that *it does not require work* to simply flow or change potential only or to produce a force such as an E-field or a B-field. What requires work is to dissipate some collected potential in a region or a load or to translate the force against resistance. It does not require work to collect potential energy in the form of excess ϕ onto the Slepian vector $\mathbf{j}\phi$ utilized in ordinary circuits to transport excess energy to the loads. To *dissipate* the excess ϕ from that **overpotentialized** $\mathbf{j}\phi$ — as in a resistor, where the excess collected ϕ is dissipated as scattered photons (heat) — is of course **performing work**. The author and his colleagues have filed several patent applications for devices and processes utilizing a different method of asymmetrical regauging (freely altering the potentials and potential energy in a system so as to produce force fields upon the collecting conduction electrons). In our circuits, the current dq/dt is blocked by special means in an otherwise conducting medium, so that the Poynting field energy flow $\mathbf{S} = \mathbf{E} \times \mathbf{H}$, the emf, and massless displacement current $d\phi/dt$ flow across the blocking section or "bridge" between two isolated current loops. The transmitting loop is a *sourcing* loop, optimized for production of voltage (which also optimizes the **S**-flow) with only very little current dq/dt. The receiving loop receives and stores the inflow of Poynting energy **S**, emf, and ϕ from the sourcing circuit, collecting and storing it upon charges q as $q\phi$. In other words, voltage, emf, and excess EM energy are bridged to the receiving loop without utilizing the Slepian vector $\mathbf{j}\phi$. The receiving loop is conductive and unblocked, so dq/dt is free to flow, with $\mathbf{j}\phi$ transporting the excess energy to the load where it is dissipated to power the load. This operation powers the load in normal fashion, without any load current passing back through the primary source's back emf to dissipate the dipolarity of the source. The bridging section is also a room temperature superconductive section utilizing $\mathbf{S} = \mathbf{E} \times \mathbf{H}$ as energy transport rather than $\mathbf{j}\phi$. These processes are just now being encountered in the furious research ongoing on quantum dots; however, our patent applications on the processes have already been in place for some time.

[8]Here we are limiting our discussion to rotary engines.

[9]Krauss [14] does perhaps the best at showing flow of Poynting S in circuits; Jackson [16], e.g., does not even mention it. Whenever a potential gradient is applied to a bipolar circuit, a Poynting vector S flow of field energy density then flows along the potentialized conductor and a **reference** level of S flows along the **ground** side conductor [14]. As do all electrodynamicists, however, Krauss errs in showing the flow as originating in the battery and ending in the resistor. In fact the energy flow originates

that the energy is in field energy (**E**-field and **B**-field) form, either overtly or "infolded" inside the corresponding scalar potentials [15], or both. Consequently, we must analyze Maxwell's equations as we would for radiating energy, rather than employ only the **j**ϕ circuit analysis conventionally utilized, where the collected energy is sluggishly transported by the Slepian vector **j**ϕ.[10] We show in this paper that asymmetrical self-regauging (ASR) allows permissible over-unity operation of electromagnetic engines and devices.[11]

In Gaussian units, Jackson [16] shows that Maxwell's four equations (vacuum form) can first be reduced to a set of two coupled equations in the (A, Φ) representation as follows:

$$\nabla^2\Phi + \frac{1}{c}\frac{\partial}{\partial t}(\nabla \cdot A) = -4\pi\rho \tag{1}$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} - \nabla\left(\nabla \cdot A + \frac{1}{c}\frac{\partial \Phi}{\partial t}\right) = -\frac{4p}{c}J \tag{2}$$

The result is two coupled Maxwell equations rather than four. Jackson shows that potentials **A** and Φ in these two equations are arbitrary in a specific sense, since the **A** vector can be replaced with $\mathbf{A}' = \mathbf{A} + \nabla\Lambda$, where Λ is a scalar function and $\nabla\Lambda$ is its gradient. The **B** field is given by $\mathbf{B} = \nabla \times \mathbf{A}$, so that the new $\mathbf{B}'$ field becomes

$$B' = \nabla \times (A + \nabla\Lambda) = \nabla \times A + 0 = \nabla \times A = B \tag{3}$$

In other words, the **B** field has remained entirely unchanged, even though the magnetic vector potential has been asymmetrically changed. However, if no other change were made, then the electric field **E** would have still been changed because of the gradient $\nabla\Lambda$. In that case the net change would be asymmetrical, because one obtained a **free E**-field which could then do work on the system — either beneficially or detrimentally, depending upon the specific conditions, geometry, and timing. To prevent this excess **free E**-field from appearing, the electrodynamicists simultaneously and asymmetrically regauge (transform) the scalar potential Φ so as to offset the **E**-field change due to the regauging of equation (1). In short, they also change Φ to Φ', where

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial\Lambda}{\partial t} \tag{4}$$

With that additional change, now both the net **E** and **B** fields remain unchanged,[12] even though both potentials have

in the vacuum surrounding and permeating the battery, converges into the battery dipolarity, flows out through both terminals and along both feeder lines to the resistor, then is scattered back to the vacuum from the resistor. Some of the flow is also scattered back to the vacuum from the internal resistance of the battery itself. The Poynting **S**-flow is outside the conductors, as is well-known, and in the form of field energy flow, via $\mathbf{S} = \mathbf{E} \times \mathbf{H}$, where the conductors act as **guides** or **railroad tracks** for **S**.

[10] It can be shown that normal electrical circuits nominally collect as **J**ϕ, and utilize to power the loads and losses, only about 10^{-13} of the actual Poynting energy flow $\mathbf{S} = \mathbf{E} \times \mathbf{H}$ that they evoke.

[11] Asymmetrical self-regauging collects just a tiny bit more of the raging **S**-flow that is flowing outside the conductors. E.g., if the self-regauging EM engine collects as **J**ϕ some 10^{-12} of the **S**-flow instead of the more usual 10^{-13}, it can have a COP = 10. And so on.

[12] So-called **canceling** oppositive EM fields are actually produced, which sum to a vector zero which the electrodynamicists discard by assumption. We point out, but do not further pursue, that the locally-produced *field energies* of the oppositive fields remain and add, even though the fields offset each other translationally, since the energy of the field is proportional to its square, and that is always positive regardless of field orientation. Thus, **trapped** EM energy has been localized in spacetime in the symmetrical regauging of CEM, and this rigorously is a gravitational change and therefore a local curvature of spacetime *a priori*. The electrodynamicists in their symmetrical neatness have ignored the fact that gauge symmetry transformations are accompanied by local gravitational changes. Heaviside became aware of this type of relationship, and worked out a theory of electrogravitation

changed and the fundamental stored energy of the system has changed. Unchanged force fields just mean that only force-free potentials have been utilized to effect the change in potential energy. It also means that the net summation of the two *asymmetrical* regaugings has been entirely *symmetrical.*[13]

Jackson points out that, conventionally, a set of potentials (A, Φ) is habitually and *arbitrarily* chosen by the electrodynamicists such that

$$\nabla \cdot A + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \tag{5}$$

This *net symmetrical* regauging operation successfully separates the variables, so that two inhomogeneous wave equations result to now yield new Maxwell's equations as follows:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \tag{6}$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = -\frac{4\pi}{c} J \tag{7}$$

Thus the two previously coupled Maxwell equations (1) and (2) (potential form) have been changed to the form given by equations (6) and (7), to leave two much simpler inhomogeneous wave equations, one for Φ and one for **A**.

Of course this arbitrary *net symmetrical* regauging (net S-regauging) is quite useful for purposes of simplifying the theory and for easing calculations. But its *unquestioning* and rather universal usage has arbitrarily eliminated the freedom of the system designer to *asymmetrically* regauge the system's potentials, and use the resulting excess free force fields to change the stored energy in the system without himself performing extra work upon the system. So we advance the condition for violating this S-regauging, exclusion of net A-regauging, and **frozen gauge** process as

$$\nabla \cdot A + \frac{1}{c}\frac{\partial \Phi}{\partial t} \neq 0 \tag{8}$$

Any regauging of the potentials that complies with equation (8) will *a priori* produce one or more excess forces in the system. By controlling the regauging, the engine designer is then able to control where, how, and when these excess forces appear, and whether they enhance the engine's operation or hinder it.

DISCUSSION

Equation (8) has now become the first principle of asymmetrical self-regauging (ASR) for over-unity electromagnetic engines and devices. That is, we are now free to A-regauge in a *nonconservative* field manner, where excess force fields automatically appear for our use in the system. All that remains is for the designer to (1) evoke "nonconservative" (asymmetrical) regauging in accord with equation (8); (2) have the engine assembly itself perform this nonconservative A-regauging in some sector or part of its normal operation, (3) insure that any "free force" that is produced can do some positive work upon the system, so as to increase its collected energy, or (4) insure that the "free" forces that are otherwise produced do not degrade the system (reduce its energy). **These four considerations**

based on his S-flow theory (which added closed-loop circulations of energy which vectorially summed to net zero). Those "trapped EM energy flow loops" were *gravitational*, in Heaviside's theory. His hand-written notes on this electrogravitation theory were found long after his death, beneath the floorboards of his little garret apartment [17]. Nothing has been done with Heaviside's *engineerable* draft theory of electrogravitation.

[13] Physicists love symmetry, turn to it at every opportunity, and will do almost any mathematical manipulation to obtain it, because they regard it as "beautiful." And so it is. Performing work, however, requires breaking symmetry to produce a force, and then using that force to do the work. If we wish to build a system that produces more work output than the work that we ourselves have to do upon it to run it, then *a priori* that system must be *asymmetrical* and — to many physicists — "*ugly*."

we now advance as the primary or master principles of asymmetrical self-regauging of electromagnetic engines and devices for permissible over-unity efficiency.

For simplicity, the system designer may wish to A-regauge only one potential, producing a desired **free** force $\mathbf{F}_1$ to work on the system and increase its energy, while allowing any other extraneous force $\mathbf{F}_2$ to appear, but just **bottling up** that additional force $\mathbf{F}_2$ so that it cannot do any work at all on the system and therefore cannot degrade the system's operation. A most useful ASR corollary that immediately suggests itself is to simply A-regauge onto that force operation that normally produces the back-drag in an engine or device, to either *eliminate* the back-drag altogether or reverse its algebraic sign so that it becomes an *assisting* force instead of a *hampering* force.[14]

In short, the electrodynamicists have previously *assumed away* the capability of work-free **refueling** of an electromagnetic system directly from the local vacuum,[15] because they have deliberately designed their systems *not to self-evoke and positively utilize asymmetrical self-regauging of the local vacuum potential*. Thereby electrodynamicists have narrowed the Maxwellian EM gauge theory model to an artificially closed (symmetrical) subsystem of equations that utilize a single fixed gauge, which prohibits the free opening of the system and free receipt of excess vacuum potential energy. *Maxwell's equations themselves do not require this*, and they do allow regauging asymmetrically to place the system in disequilibrium so that it freely receives and utilizes excess energy from the surrounding vacuum.

By arbitrary habit, electrodynamicists have discarded the major EM over-unity mechanism: *Asymmetrically self-regauging without requiring that external work be done on the system*, in order to freely gather in and collect excess potential energy in the system, with associated excess forces, whereupon that excess collected/stored energy can then be used **drive** the forces to freely power the system and its loads. They have also discarded the major over-unity corollary of *regauging asymmetrically so that the normal back-drag or back-emf work — usually done upon the system to reduce its kinetic energy — vanishes or reverses sign and becomes beneficial work done in the opposite sense, to freely increase the energy of the system.*

All that is required for **self-powering** EM engines directly powered by the vacuum, is that (a) the engine asymmetrically self-regauge to produce COP>1.0, and (b) positive feedback (from the output) of 1.0 be utilized to its input, in a clamped and controlled fashion. The feedback can easily be designed and applied, once the fundamental engine is designed for self-regauging and over-unity efficiency. The remaining excess output can then be utilized to power loads, while the engine seemingly **powers itself**.

Over-unity EM operation via work-free *asymmetrical* regauging has been inherent in the Heaviside/Maxwell equations for a century, and electrodynamicists have just conveniently and arbitrarily *assumed* it away by limiting the theory to prevent regauging the potentials except for a single prescribed *net symmetrical* regauging.

ALL THREE EXAMPLE ENGINES USE REGAUGING OF MAGNETIC SCALAR POTENTIAL

Let us now look at three specific engines which use regauging for over-unity operation.

[14] Thus the long and tedious effort of my colleagues and I to create load circuits that asymmetrically self-regauge their potential difference (source voltage) without allowing load current to pass back through the primary power source and do work inside it to destroy its dipolarity.

[15] Again we strongly stress that asymmetrically regauging a potential in the system also regauges the local vacuum potential and the intensity of the vacuum potential's constituent bidirectional EM energy exchange with the system. It directly alters the stored energy of the system. See again [15] to see this clearly.

All three devices freely and asymmetrically *self-regauge* (recharge or discharge, as required) the magnetic scalar potential energy of the device in a selected A-regauging sector.[16][17] Johnson uses a multivalued magnetic scalar potential to accomplish this A-self-regauging completely by means of a nonlinear permanent magnet rotor and nonlinear permanent magnet stator, without any electrical input. The magnetic Wankel and Kawai engines both use external electrical input to create or alter a magnetic scalar potential in the A-regauging section.

CONSERVATIVE AND NONCONSERVATIVE FIELDS AND MULTIVALUED POTENTIAL (MVP)

Normal engine designers work with *conservative* fields, which require single-valued potentials. (see Fig. 1) They consider any hint of asymmetrical regauging operations, as well as the multivalued potential (MVP), to be nuisances, since such regauging may immediately involve *nonconservative* electromagnetic fields (see Fig. 2). Most of the favored **engine design** laws and trusted circuit laws **blow up** during asymmetrical regauging, whether by electrical injection or the MVP region. So electrical power engineers just design conventional electromagnetic engines to avoid the MVP or eliminate it. On the other hand, if the designer deliberately evokes and properly *uses* the free **jump** of stored potential energy that occurs in an MVP-containing sector of an engine, a standard gauge-theoretic analysis will show that one can legitimately have over-unity coefficient of performance from that engine because the self-regauging is now asymmetrical. (see Fig. 3) I first pointed out that the multivalued potential could be used for free energy systems in 1980 [19].

MULTIVALUED POTENTIAL (MVP) FREQUENTLY OCCURS IN NATURE

The multivalued potential occurs widely in nature [20], and *particularly* in magnetics. In fact, it is quite often the *rule* rather than the exception. Still, the MVP is usually ignored by conventional engine designers, and many electrical engineers have hardly heard of it. While asymmetrical change of gauge[18] of the magnetic potential produces additional force fields, these excess force fields themselves need not be *detrimental* to the system's operation, but can actually be arranged to *enhance* it.

It is easiest to alter a magnetic scalar potential on a rotary electromagnetic engine by simply energizing a coil. If the coil is oriented radially, its associated **B**-field will not perform radial work on the rotor. Any *tangential* **B**-field with respect to other magnetic scalar potentials nearby, resulting from creation of the magnetic scalar potential in the regauging sector, will either be (a) rotor-accelerating, or (b) rotor decelerating. Obviously one wants the change (regauging) of the magnetic scalar potential to either (c) accelerate the rotor, or (d) zero out the back-drag that

[16]Note that, in my previous article "Free Energy: The Final Secret" [18], the shuttling of pure potential between isolated current loops is actually a work-free *asymmetrical regauging* of the potential energy of the receiving current loop. Electrical power sources do not furnish a single electron to a circuit; instead, the conduction electrons come from the conductive materials of the circuit (e.g., from the copper in the wiring). Hence electrical power sources cannot *furnish* current per se. What they *do* furnish is (a) Poynting energy flow $\mathbf{S} = \mathbf{E} \times \mathbf{H}$, (b) potential ϕ, which flows as massless displacement current $d\phi/dt$, and (c) emf, which is simply the dipolar potential difference of the conductors. All that an electrical power source does is *asymmetrically regauge its external circuit.*

[17]All dipolar electrical sources are already *free energy sources.* A dipole (source) will furnish energy flow (i.e., Poynting **S**-flow) indefinitely, so long as none of its energy flow that is collected in the exterior circuit is utilized to drive the spent (depotentialized) electrons back through the source's back emf, thereby performing work inside the source to destroy its bipolar separation of charges. Ironically, electrical power source designers have never built anything *but* free energy sources; they simply have been trained to design their *use* to be self-mutilating.

[18]We painfully stress that asymmetrically regauging an electrical system can be as simple as obtaining a sudden jump in voltage, without concomitant increase in dq/dt. Magnetically, asymmetrical regauging appears as a sudden change in pole strength, or polarity, or both. If the regauging is deliberately arranged to result in a *higher magnitude* of magnetic scalar potential being **suddenly injected** into the regauging sector of a magnetic device, then that system has been momentarily **opened** thermodynamically and an additional amount of stored potential energy has **freely** appeared in the system, directly from the surrounding vacuum, and this energy has been or can be stored on magnetic poles in that regauging sector. Additional force fields now exist between those augmented poles and other poles in the system, and these can be deliberately arranged so that they do *free, beneficial work* upon the system to increase its energy.

otherwise decelerates the rotor, or (e) do nothing at all. So one will adjust the polarity and strength -- and timing and geometry -- of the magnetic scalar potential created by the radial coil(s) accordingly.

For those unfamiliar with modern gauge theory, we point out that this discussion is completely consistent with Maxwell's equations, which formed the first true gauge theory. It is simply *a matter of preference by the electrodynamicists*, e.g., that the indefinite potentials in the Maxwellian equations in potential form are manipulated by *symmetrical* regauging to separate the variables and freeze the gauge. To perform net symmetrical regauging, of necessity they utilize two simultaneous asymmetrical regaugings anyway! By use of an MVP region and/or other *net asymmetrical* self-regauging region in an engine, however, the system designer may cause the system to freely collect energy from the vacuum and utilize it for COP>1.0 efficiency.[19]

REGAUGING IS WORK-FREE, AND CAN PRODUCE ADDITIONAL ORTHOGONAL FIELDS

Work requires the translation of a force through a distance. *Net symmetrical* regauging changes only the potentials, the *net* change in the force fields already present is zero. *Asymmetrical* regauging changes the potentials and also produces excess force fields. Even so, the extra force field(s) created may be located so that no work can be done by it (them) upon the system.[20] However, even when these excess forces are unable to translate and are therefore negated, the altered scalar potential(s) associated with them are also free to create any number of additional force fields *at right angles* to those nontranslating excess force fields, depending upon the relationships between the regauged potential and various potentials in adjacent locations at right angles nearby. Let us examine that more closely in Fig. 4.

Rigorously, $W = \int \mathbf{F} \bullet ds$. That is, work is done by a translating force only along the direction of translation. Ancillary force field $\mathbf{B}_2$, formed at a right angle to the radial force field $\mathbf{B}_1$ in stator coil A, can do tangential work on rotor C without any additional **drain** or effect upon the radial coil other than the normal drain utilized to form the primary $\mathbf{B}_1$ field. Simply put, *radial* forces do not perform work at right angles (tangentially) to their direction. However, at the fixed stator point S_1 where radial magnetic force $\mathbf{B}_1$ exists, a magnetic scalar potential Φ_1 also exists. At the nextmost tangential stator position S_2, a scalar potential Φ_2 exists. If $\Phi_1 - \Phi_2 \neq 0$, then a tangential magnetic field $\mathbf{B}_2$ exists between S_1 and S_2. By adjusting the strength and polarity of Φ_1, magnetic field $\mathbf{B}_2$ can be made to *assist* the rotation of rotor C, in what would otherwise be a **back drag** or decelerating sector. In short, the tangential back-drag force normally existing between $\Phi_1 - \Phi_2$ in the normally-decelerating sector can be reversed and made to *accelerate* the rotor C in that sector, without requiring excess work in stator coil A or in stator electromagnet assembly P when the strength and polarity of Φ_1 are regauged. In short, one can regauge in the normal back-drag region of the rotation, and *reverse what would normally be back-drag into positive acceleration*.

Both Johnson and the magnetic Wankel do this in their engines. Johnson regauges via a complex assembly of stator magnets (see Fig. 5) that provides an MVP. The magnetic Wankel (see Fig. 6) regauges by utilizing a radial coil

[19] Maxwell's equations are *macroscopic* equations. It is highly ironical that the very insistence of the physicist on beauty in his equations, has discarded the breaking of macroscopic symmetry in the continuous, violent exchange of energy between any system and the surrounding vacuum. This has discarded any system **gating** of vacuum energy and using it. Because of this, the power meters stay on our factories and homes, and the gas meters stay on the gas pumps where we fill up the gas tanks of our automobiles -- steadily emptying our billfolds and polluting the planet in the process.

[20] Note that to *create* this extra force does not require work during the A-regauging operation. After the extra force is created by A-regauging, then the force may act upon the system or not act upon the system, according to how the designer has arranged for it to appear. Even when the force is used to beneficially do work upon the system to increase the system's energy, that work occurs after its work-free creation by the A-regauging. As is well-known in foundations of quantum mechanics, forces are not primary causes of EM phenomena, but are effects produced in and on the charged particles of the system. See Aharonov and Bohm, 1959 [4].

with a weak current through it, where the current is sharply broken by ignition points to provide a **nearly free**, momentarily high magnetic scalar potential[21] and thereby perform the regauging nearly **for free**.

ASYMMETRICAL REGAUGING IS FREE ELECTRICAL OR MAGNETIC "REFUELING"

Asymmetrically regauging a sector of a rotary electromagnetic engine is just like refueling a car by putting gas in its gas tank: During the regauging operation, the system is an **open** system receiving an injection of excess potential (stored) energy from the surrounding vacuum — except that in the electromagnetic case the refueling is *free*. (see Fig. 3) Excess stored energy is injected from the vacuum into the system from the **refueling** jump due to asymmetrical regauging. This excess energy can then be dissipated in the load during the remainder of the rotary cycle — just as a refueled automobile can dissipate its additional fuel energy in powering the car, until it is time for refueling again.

By using one or both of these two master principles — (a) asymmetrical self-regauging and (b) use of a multivalued potential for regauging — electromagnetic engines can freely break the symmetry in their energy exchange with the surrounding vacuum, and extract and use excess energy from it. Thus they can *permissibly* exhibit COP>1.0, without violating the laws of physics, nonequilibrium thermodynamics, Maxwell's equations, or advanced electrodynamics when the arbitrary restriction to symmetrical regauging is removed. And a totally-permanent-magnet engine can power itself and its load, by excess energy freely extracted from the vacuum via its asymmetrical self-regauging.

THE JOHNSON FORCE-PRODUCING MAGNETIC GATE

Fig. 5 diagrammatically illustrates the operation of the force-producing magnetic gate in Johnson's permanent magnet motor. As Johnson has shown, by using a multivalued potential in his gates, a rotor magnet is attracted into a highly nonlinear stator gate region where the MVP is located. When it enters the MVP, the rotor encounters a dramatic jump in the stator's magnetic scalar potential with a change of polarity. This is an asymmetrical self-regauging. In turn, this produces a sudden *accelerating* tangential force in the region which would otherwise have been the back-drag region. This accelerating force propels and accelerates the rotor magnet on through the gate and out of it.

Rigorous force meter measurements taken at 0.01 second intervals prove that this occurs as the rotor passes through Johnson's gate. A representative plot of such force meter measurements is shown as the dotted line in Fig. 3.

Johnson thus uses a highly nonlinear magnet assembly of special design to create an MVP and asymmetrical self-regauging in his gate. The MVP produces a **magnetic potential jump** and a reversal of the (otherwise) exiting back-drag on the rotor. In short, Johnson causes the system to be automatically **refueled** in the asymmetrical self-regauging sector, so that it can continue to rotate and power a load.

THE MAGNETIC WANKEL ENGINE

Fig. 6 diagrammatically shows the scheme of operation of the magnetic Wankel engine. Here a set of permanent magnets, each at an angle to the various radial lines of the device, comprises a slightly widening spiral stator that is **almost** circular but not quite. A circular rotor with a sector magnet is mounted inside this spiral stator. An end gap exists in the stator as shown, so that the stator is not a completely closed ring. The direction of rotation for the rotor is clockwise as shown. For demonstration of the principle, the beginning air gap is 0.1 mm and the ending air gap is 5 mm.

A permanent magnet is mounted along the perimeter of an angular sector of the rotor. It is magnetized, say, with the north pole facing radially outward, and the south pole facing radially inside. In the stator, the permanent magnet

[21] As can be seen, the direct excess B-field force produced by the Wankel coil does not translate because it is radial. Hence it does no work on the rotor. However, the associated tangential force between the altered magnetic scalar potential at the end of the coil, and the nearby magnetic scalar potential of the initial permanent magnet, does act tangentially on the rotor to accelerate the rotation. Hence this *associated* **excess force** is also free and highly beneficial, because it accelerates the rotor back to the initial position and **resets** the engine.

north poles are facing radially in toward the rotor, but at an angle, and the south poles are facing radially outside but at an angle.

Thus *tangentially* the north pole of the rotor is in a nonlinear magnetic field, and it will experience a clockwise force and acceleration from position 1 (where the air gap is the minimum) to position 2 (where the air gap reaches maximum).

If this were all there was to it, the magnetic Wankel motor would not be over-unity because the tangential field is conservative. When the rotor crossed the end gap in the stator between point 2 and point 1, very sharp and dynamic braking work would be done back upon the rotor magnet by the field of the stator magnets at point 1. This braking work would precisely equal the amount of dynamic acceleration work that was done in accelerating the rotor magnet from position 1 to position 2, in accordance with a distortion of Fig. 1. For an absolutely frictionless machine with no losses, the coefficient of performance (COP) would be 1.0. Since any real machine will have at least some friction and drag, the actual COP would be less than 1.0.

Let us now utilize the notion of the magnetostatic scalar potential and asymmetrical self-regauging to examine a new situation in the end gap.

Technically, let us regard a single unit north pole in the rotor, going from position 1 to position 2 (the acceleration cycle, where the engine will deliver shaft horsepower against a load), and then from position 2 to position 1 (where the magnetostatic scalar potential must be asymmetrically regauged to equal or exceed the potential at position 1, in order for the rotor to continue unabated or even further accelerate. I.e., in the separation gap, an asymmetrical regauging operation must be done so that the **stator to inner** potential is increased equal to or exceeding the **stator to inner** potential of position 1.

In normal machines, the A-regauging part of the cycle is not self-initiated. Conventionally it is where the design engineer *forcibly* inputs energy from outside the system *to do brute physical work* on the machine to *forcibly wrestle* its energy storage back to initial RESET conditions. In the past engineers have automatically assumed COP<1.0 without exception, since their forcible RESET *work* was always equal to the maximum theoretical energy output to the load during the motor part of the cycle from point 1 to point 2, plus any losses in the **wrestling** process and in the machine itself.

For over-unity we must perform the regauging or RESET of the system's energy storage, *without engaging in the conventional "wrestling match."* Now the wrestling match is usually against the back-drag forces of the engine. For that purpose, an electromagnet is utilized to fill the end gap in the stator, where the back-drag forces will otherwise appear. The electromagnet is arranged so that when activated its north pole will face radially inward. A small current activates the coil weakly, through a distributor with breaker points. At the proper timing (i.e., when the rotor is directly opposite the electromagnet polepiece), a set of ignition points is sharply broken in the circuit with the coil of the electromagnet. Momentarily, a very high magnetic scalar potential will appear at the end of the coil[22] as the collapsing field is highly amplified and trying to sustain the previous current in its previous direction. The end result is the formation of a strong magnetostatic scalar potential (pole), of north polarity, on the stator polepiece facing the rotor. Note that no *radial* work can be done on either the stator polepiece or the rotor by the radial force from this high potential, because they cannot move *radially*.

The magnetic scalar potential in the end gap is now higher than the nextmost potential at position one. Consequently, a clockwise tangential magnetic force field exists between the end gap potential and the lower potential at position one. This force cannot do **back-drag** work on the fixed stator. It cannot oppose the coil's radial B-field, because it is orthogonal to it. An *assisting* clockwise tangential force, therefore, appears upon the rotor, and the rotor is *accelerated* and **boosted** out of the stator gap and back past point 1. At that point the electromagnet has lost its potential, but the engine has now been *regauged* and again is in the clockwise acceleration field of the rotor-stator permanent magnets.

[22]As is well-known, an electrostatic scalar potential and associated **E**-field will also appear across the coil, but here we are only interested in the magnetic scalar potential.

In short, the rotor perceived the sudden change of magnetostatic scalar potential from the electromagnet in the stator gap as a pseudo-MVP, and the system received a sharp influx of potential energy, without work except for that lost in the electromagnet circuitry. That potential energy was used to deliberately create a helpful tangential force field, which accelerated the rotor and increased the kinetic energy of the engine. All that it cost to produce this beneficial effect was the small loss in operating the coil. Since that loss can be made quite nominal by conventional electronic practices, the engine permissibly provides COP>1.0. It can therefore be rigged to power itself and a load simultaneously.

Placed in an electric vehicle with necessary switching circuitry and ancillary equipment, a properly designed magnetic Wankel engine and its derivatives should be capable of starting from a single ordinary battery, then powering the vehicle agilely, powering the accessories, and constantly recharging its own battery — all three simultaneously.

THE KAWAI ENGINE

Fig. 7 shows eight snapshots of the rotor advance of a typical Kawai engine, taken from Kawai's patent [21]. This is one end rotor/stator side of a two rotor device, where a similar rotor/stator device is on the other end of the central shaft 11. In Fig. 7A, polepiece 14 has three outward teeth 14b dispersed equally around the circumference, alternated with three notches. An end magnet 13 provides the source of flux passing through the polepiece. With the electromagnets de-energized, their core materials 16c, 16d, 16g, 16h, and 16k, 16l are shown shaded, by flux from central magnet 13 outward through teeth 14b.

In Fig. 7B, electromagnets 16a, 16e, and 16d are energized. The shaded area shows the sharp convergence of the flux from magnet 13 through polepiece 14 and the edge of teeth 14b. Since the electromagnets are magnetized in attracting mode, the rotor will experience a torque tending to widen the flux path from magnet 13 to the activated electromagnets. Thus a clockwise torque exists on the rotor, and it will start to rotate clockwise.[23] Note also that each electromagnet is operating independently of the other two.

As shown in Figs. 7C, 7D, 7E, and 7F, the rotation of the rotor continues clockwise, widening the connecting flux path to the three activated electromagnets. During this time the torque on the rotor is clockwise.

In Fig. 7G, the flux path to the activated electromagnets is fully widened. Also, the leading edges of the three teeth are just beginning to enter the domains of the next electromagnets 16j, 16b, and 16f. This is getting symmetrical to the original position shown in Fig. 7B. Consequently, the electromagnets 16i, 16a, and 16e are deactivated, and electromagnets 16j, 16b, and 16f are activated. This action *asymmetrically self-regauges and resets* the engine back to the original situation in Fig. 7B. The action cycle begins anew. As can be seen, in each complete rotation of the shaft, each of the three teeth of the rotor will be asymmetrically self-regauged 12 times. So 36 total self-A-regaugings/resettings/refuelings are utilized per shaft rotation.

In each stator coil, at energization a tooth is just entering that coil. Energized in attractive mode with respect to the ring magnet around the shaft, the flux in the polepiece **jumps** from fully widened flux (and small or vanishing radial torque on the rotor) to angled and narrowed flux (with full radial clockwise torque on the rotor). This is an asymmetrically self-regauging action. As previously explained, the narrowed flux and its angle exert a clockwise accelerating tangential component of force upon the rotor. By the asymmetrical self-regaugings of the engine, each coil is de-energized prior to beginning to exert radial back emf (which it would do if it remained energized as the trailing edge crossed it and again narrowed the flux path). So the Kawai engine uses normal magnetic attraction to accelerate the rotor for a small distance, then asymmetrically self-regauges to zero attraction to eliminate the back-drag portion of the attractive field. It regauges to zero as the RESET condition.

[23]Note that the Kawai patent contains an error, stating at first that the torque and rotation are counterclockwise, then showing it moving correctly clockwise from figure to figure in the series.

For appreciable power and smoothness, the Kawai engine uses an extensive number of asymmetrical self-regaugings per axle rotation, being 36 times on each end, or a total of 72 for the two ends. The force field of each coil, accompanying its increased magnetostatic scalar potential, is oriented radially inward, so that radial work cannot be done by the coil on the rotor because the rotor does not translate radially. Advantage is taken of the initial clockwise acceleration force initially produced, and self-regauging eliminates the counterclockwise **decelerating** drag that would be produced without the regauging.

The major benefits of the Kawai arrangement are that (a) multiple asymmetrical self-regaugings occur for a single rotation of the rotor assembly, enabling high power-to-weight ratio, (b) each electromagnet is energized only when positively contributing to the clockwise torque that drives the rotor, and (c) each coil is de-energized to asymmetrically self-regauge the system during those periods when the coil would otherwise create back-drag (counterclockwise torque) if it remained energized.

So the Kawai engine delivers what it advertises: It dramatically reduces or eliminates the **back-drag** fields of the stator electromagnets, because there are no back-drag fields activated in the electromagnets during the back-drag sectors. A conservative field cycle is one in which the back-drag is equal to the forward boost. Self-eliminating the back-drag portion of the cycle is a form of asymmetrical self-regauging, and makes the net field highly nonconservative. Note that again it was accomplished by a change in the magnetostatic scalar potential, which was reset to zero by the de-energizing coil during the back-drag portion of an otherwise conservative cycle. The Kawai engine therefore uses asymmetrical self-regauging and nonconservative fields in order to legitimately achieve over-unity operation.

Because of its numerous ASRs and back-drag eliminations in a single rotor rotation, this engine definitely can provide a COP>1.0. Placed in an electric vehicle with necessary switching circuitry and ancillary equipment, a properly designed Kawai engine and its derivatives should be capable of starting from a single ordinary battery, then powering the vehicle agilely, powering the accessories, and recharging its own battery — all three simultaneously. And it fully complies with all the laws of physics and nonequilibrium thermodynamics. Equilibrium thermodynamics — with its infamous second law — rigorously does not apply to the system during its asymmetrical self-regauging operations.

CLOSED LOOP (SELF-POWERING) OPERATION

Both the Kawai and magnetic Wankel engines require some external input power, at least in the configurations shown to date. However, both engines are technically capable of over-unity — e.g., in his U.S. patent, Kawai quotes performance measurements indicating 318% efficiency. Obviously, such a system can be close-looped by simply hooking it to a generator, and using positive feedback of a portion of the generator output to run the engine while using the remainder of the output to power a load.

The Johnson engine is inherently already self-powering, since it requires no external power input in the conventional fashion. Because of the broken symmetry produced by the asymmetrical self-regauging, in any such self-powere d engine there is indeed a continual input of free energy flow from the vacuum, via the asymmetry created in the violent virtual photon exchange with the particles and atoms comprising the magnets. A dipolar magnet simply acts as a gate in that asymmetrical energy exchange, as indeed does the bipolarity of an electrical power source.

CONCLUSION

We have advanced the major principles of over-unity electrical machines, and shown that in fact Maxwell's equations permit such machines, using the principles stated. (see Fig. 8) Presently the inventors of the three engines mentioned have developed prototype engines which (1) apply either a multivalued potential, an asymmetrical self-regauging, or both; and (2) produce COP>1.0. The Johnson engine is already self-powering. Both the magnetic Wankel and Kawai engines are readily convertible to self-powering embodiments. It would appear that these and other asymmetrically self-regauging electromagnetic engines should now move into full development for introduction upon the world market, to usher in a new age of cheap, clean energy benefits for everyone.

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Magnet Motor," U.S. Patent No. 4,151,431; Apr. 24, 1979. Johnson is presently filing a new patent on his lengthy work with the multivalued potential in highly nonlinear magnets, which resulted in his successful "asymmetrically self-regauging" magnetic stator gate that led to his first embodiment patented in 1989.

2. A popular press article may have provided sufficient operational detail to allow analysis of the technical principle involved in a "magnetic Wankel" engine. See David Scott, "Magnetic "Wankel" for Electric Cars," *Popular Science*, June 1979, p 90-91. We have analyzed the engine accordingly. Observing the Wankel design, it is apparent that very powerful magnets are necessary in order to achieve a well over-unity coefficient of performance. Here one should mention Takahashi's development of probably the most powerful ceramic magnets in the world. It would seem that engines such as the magnetic Wankel could very much benefit from using the powerful Takahashi permanent magnets.

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5. Robert Bruce Lindsay and Henry Margenau, (1963) Foundations of Physics, Dover Publications, New York, p 283-287, p 283. A "field of force" at any point is actually defined only for the case when a unit mass is present at that point.

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7. J.D. Jackson, Classical Electrodynamics, 2nd ed., John Wiley & Sons, New York (1975), p 220-223.

8. A series of articles on over-unity processes and devices, has also been published in *The Virtual Times*, Internet node WWW.HSV.COM , e.g., see T.E. Bearden, "The Master Principle of EM Over-unity and the Japanese Over-unity Engines: A New Pearl Harbor?" *The Virtual Times*, Jan. 1996. We point out an error in this and two other articles, however: In them we erroneously mis-identified the magnetic Wankel engine as the Takahashi engine. This does not affect my analysis of the *magnetic Wankel* engine. I thank Hal Fox for pointing out this *faux pas*, and my apologies to Mr. Takahashi for any inconvenience this may have inadvertently caused him. When Mr. Takahashi's engine configuration is finally released and made available, I look forward to analyzing it to see if he is utilizing asymmetrical self-regauging.

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14. John D. Krauss, Electromagnetics, 4th ed., McGraw-Hill, New York (1992), Figure 12-60, a and b, p 578 for good diagrams of the Poynting flow in a simple circuit containing a battery and a resistor.

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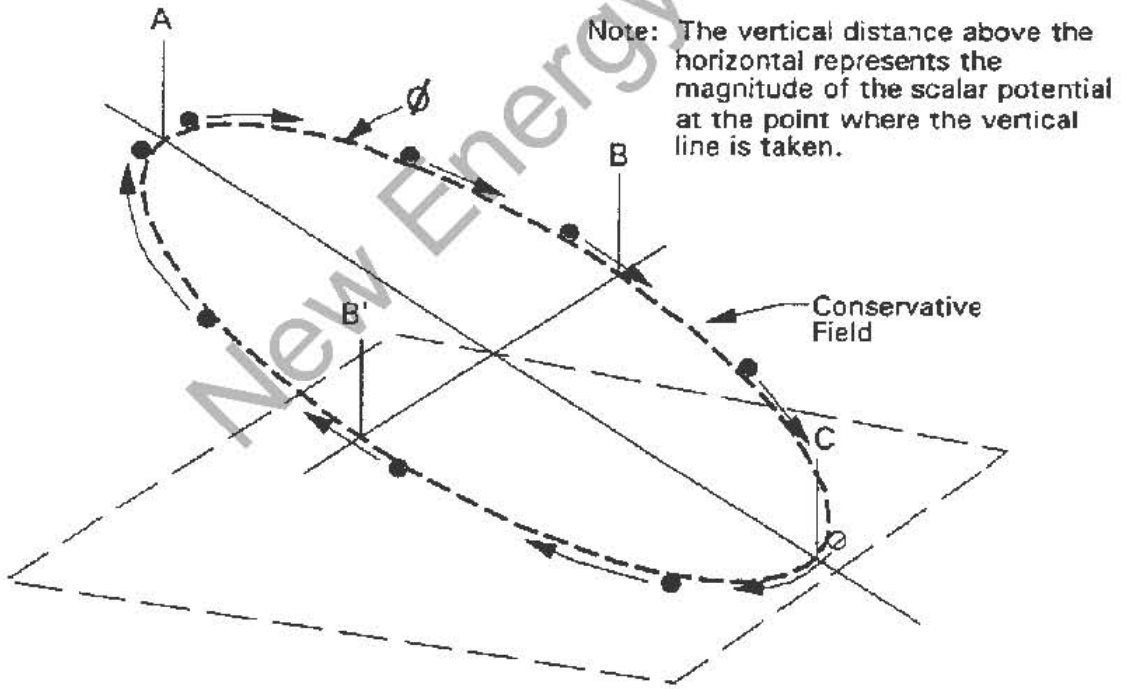
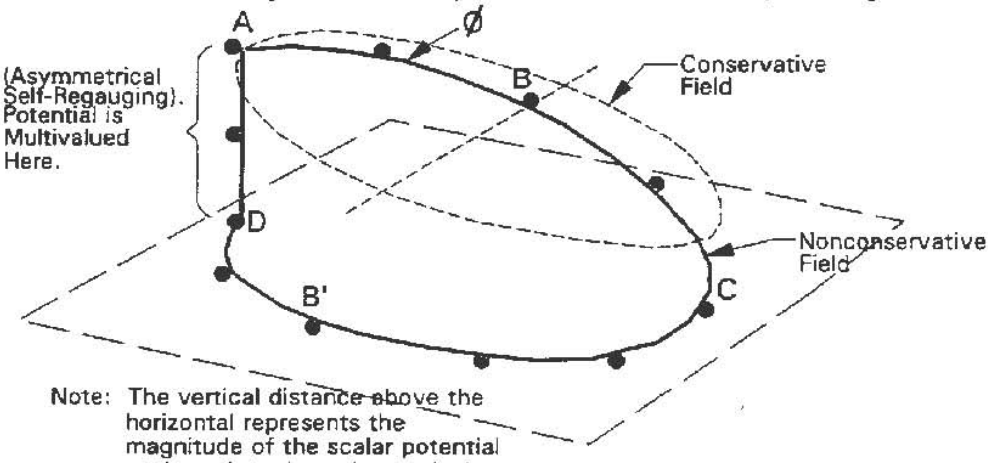


A circular closed path in potential ϕ is given by A-B-C-B'-A.
Line integral from A around any closed path back to A is conservative.
Along path A-B-C, work W(1) may be extracted from rolling ball.
Along path C-B'-A, must do work W(2) on ball, where W(2) = - W(1).

Figure 1. A Conservative Field Requires a Single-Valued Potential.

JRG-1

(Multivalued magnetic scalar potential arises readily in magnetics)

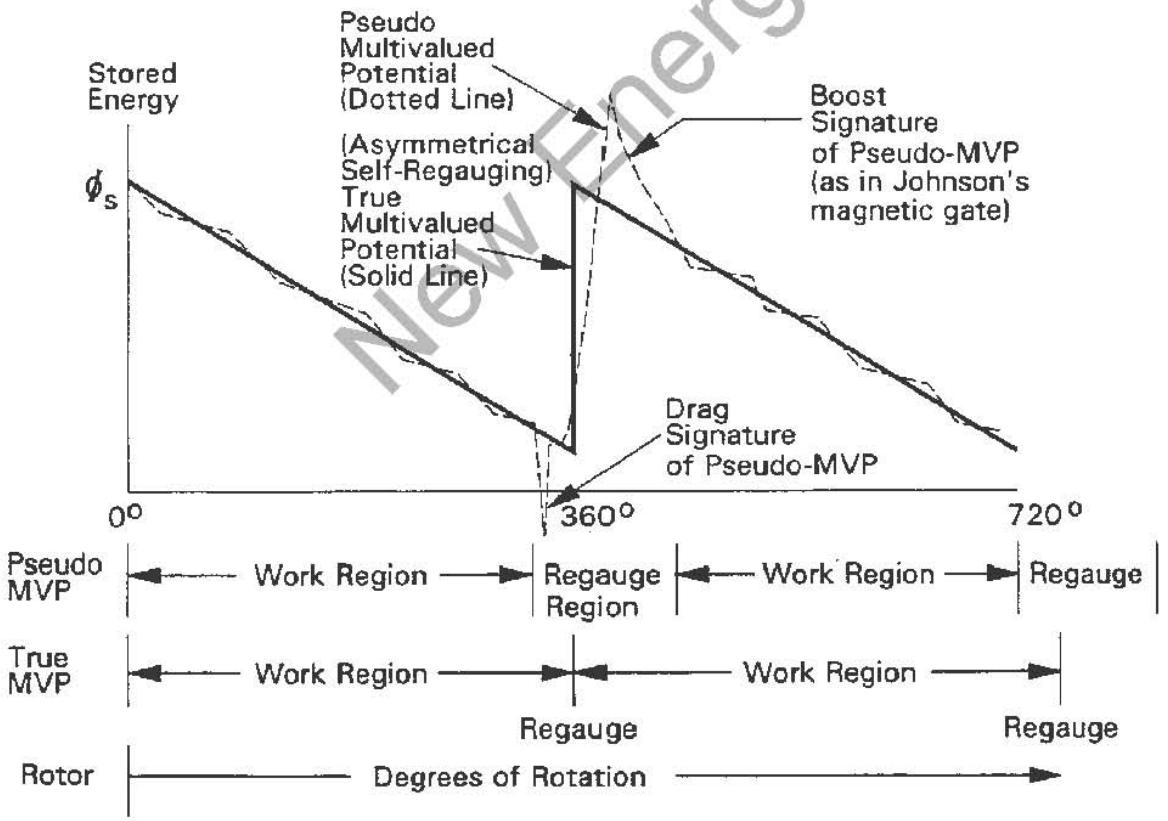


Note: The vertical distance above the horizontal represents the magnitude of the scalar potential at the point where the vertical line is taken.

A circular closed path in potential ϕ is given by A-B-C-B'-D-A.
Potential ϕ is multi-valued from D to A.
Line integral from A around this closed path back to A is nonconservative.
Along entire path A-B-C-B'-D, work may be extracted.
No work is required to go from D to A. When ball arrives at D, it also arrives at A simultaneously. I.e., the potential "jumps" in magnitude.

Figure 2. Field May be Nonconservative for a Multivalued Potential.

JFIG-2 © 1995 T.E. BEARDEN



Note: Single regauging per rotation shown. Can easily use multiple regauging per rotation.

Figure 3. "Refueling" an EM Engine by Asymmetrical Regauging with MVP.

JFIG-3 © 1995 T.E. BEARDEN

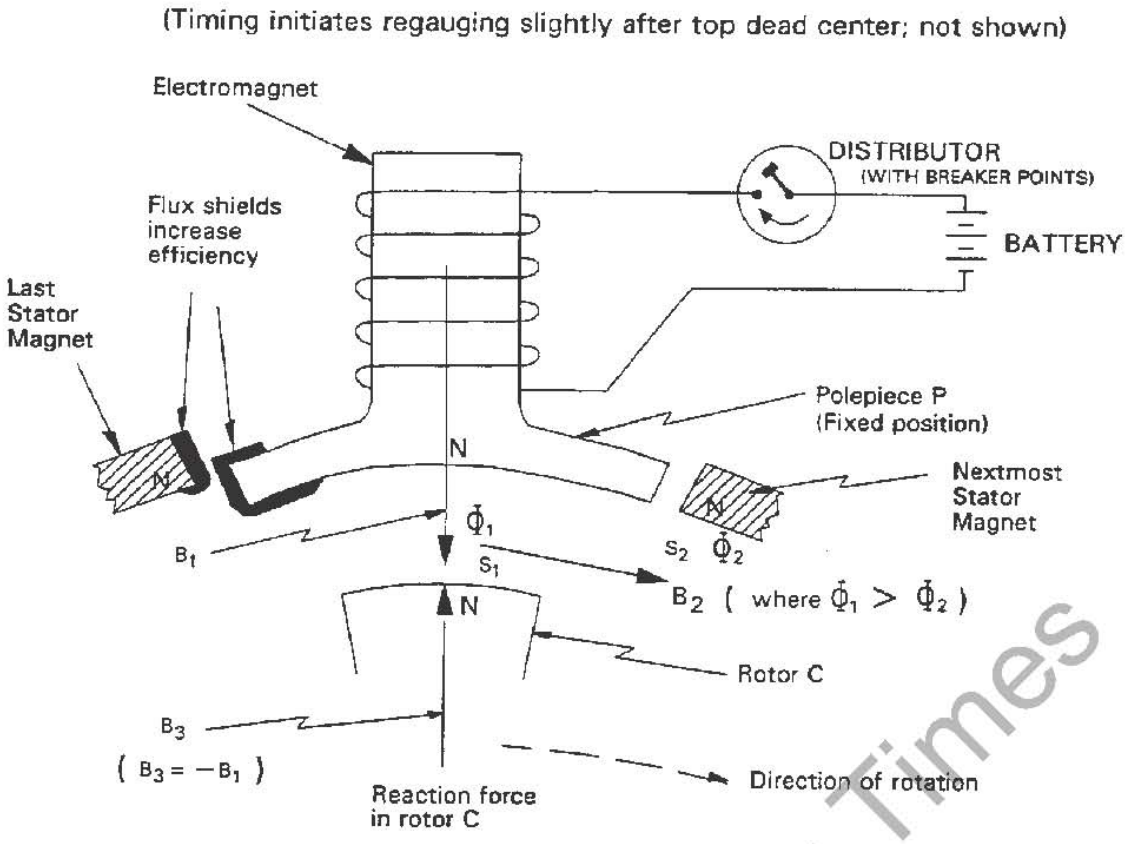
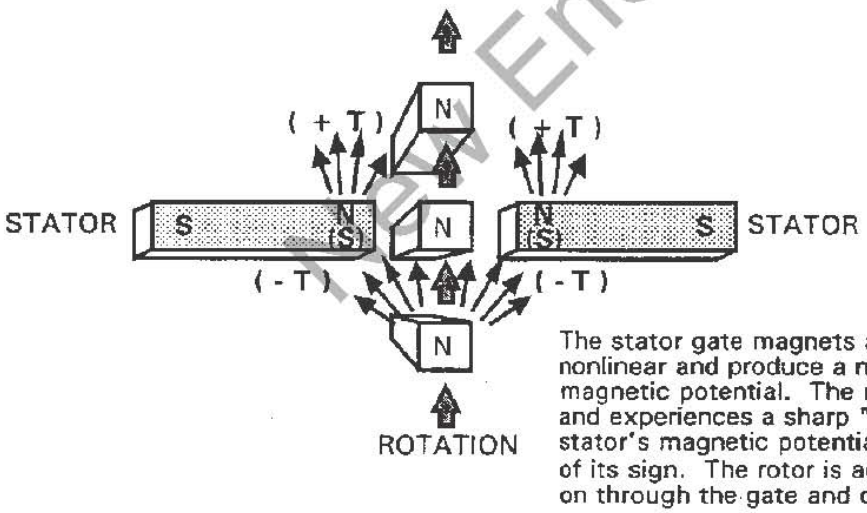


Figure 4. Asymmetrical Self-Regauging Force and Potential Relationships.

JFIG-4



The stator gate magnets are highly nonlinear and produce a multivalued magnetic potential. The rotor enters and experiences a sharp "jump" in the stator's magnetic potential, and reversal of its sign. The rotor is accelerated on through the gate and out of it.

Effectively a phase conjugation (time reversal) occurs on the leading edge. The rotor is attracted in; asymmetrical self-regauging occurs. The rotor is accelerated on out. Asymmetrical self-regauging injects free potential energy into the system, from the vacuum. Conservation of energy, the laws of physics, and the laws of non-equilibrium thermodynamics are not violated.

Figure 5. Concept of operation of Johnson's patented magnetic gate.

JFIG-5

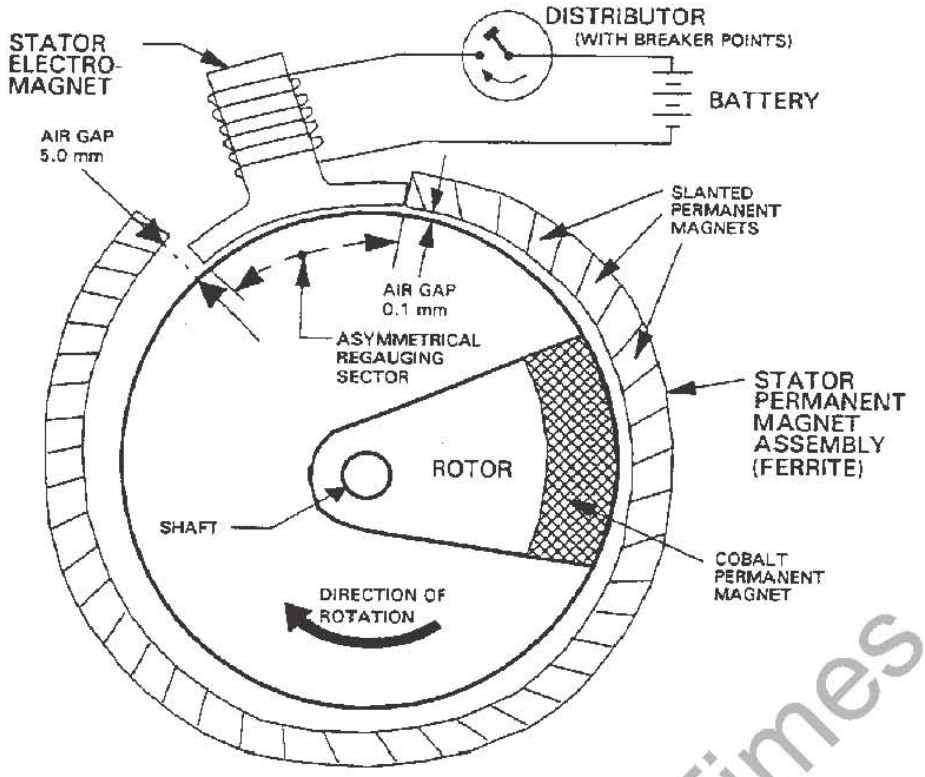


Figure 6. Magnetic Engine with Asymmetrical Self-Regauging Section

JFIG-6

Fig. A

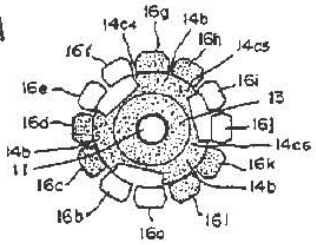


Fig. B

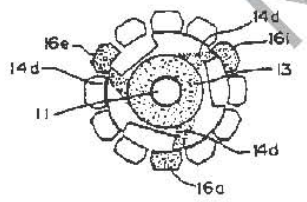


Fig. C

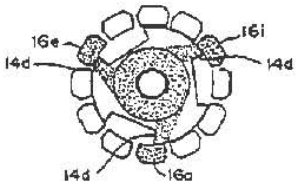


Fig. D

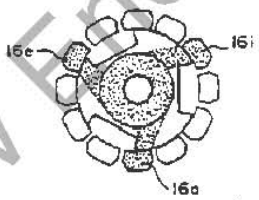


Fig. E

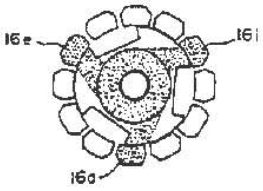


Fig. F

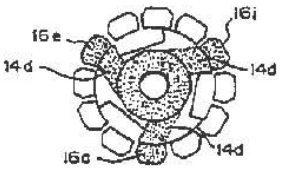


Fig. G

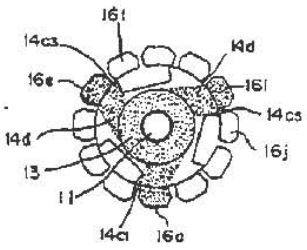


Fig. H

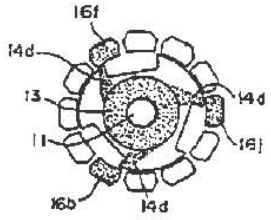


Figure 7. Rotor advance and asymmetrical self-regauging in a typical Kawai engine.

JFIG-7

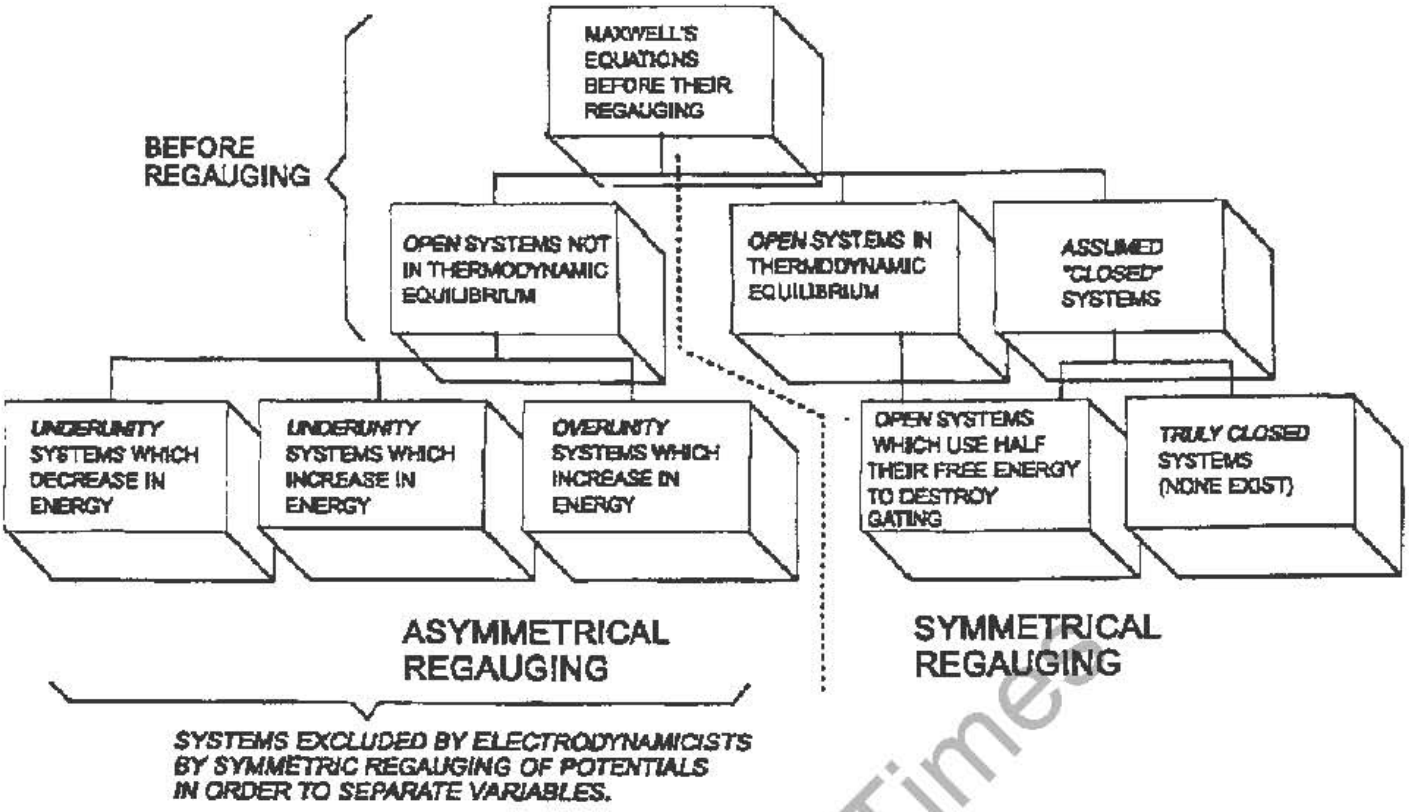


Figure 8. Maxwellian systems before regauging, after *symmetrical* regauging, and after *asymmetrical* regauging.

A NEW APPROACH TO THE COSMIC RED-SHIFT AND TO THE COSMIC MICROWAVE SOURCES

P. Anastasovski, H. Fox, K. Shoulders

ABSTRACT

Here is presented the analysis for photon-electron interaction, when the electron is free, and is under action of externally applied electric field. Equations for mass quantization and for quantization of the law of momentum conservation, obtained by the QMT (quantum mass theory) are applied in the analysis. These equations, initially determined for the atom, when its state is defined by the principal quantum number n, are applied here to the free electron when its state is determined by the magnitude of the externally applied electric field. The results of the analysis show the possibility to explain the cosmic red-shift by QMT, which can also be used to explain the origin of detected microwaves coming from the universe. The results of the analysis also suggest the possibility for their experimental verification.

INTRODUCTION

Theoretically and experimentally it is shown, by application of QMT to the ionized gases, in certain conditions, that in the photon-electron interactions, when the electron is part of an atomic system, the photon is captured by the electron incorporating its mass [1]. Because of the new assumed properties of the atom and the vacuum by QMT, the obtained results show that the atom may emit not only the optical frequency photon, which has been captured by the electron, but the photons from X- and γ-ray ranges, also. Besides that, the possibility for simultaneous emission of two kinds of photons is predicted as well, which corresponds to the valid theory (ref.1, p.58). Quantum Mass Theory is based on the MESOF (magnetic and electric susceptibilities for optical frequencies) theory [2].

Besides the fundamental aspects of these two theories, very interesting applications in many fields of science and technology could be expected. One challenging idea is about the possibility that QMT can be used for explanation of some phenomena in astrophysics and astronomy.

According to H. Fox [3]: "Photons traveling through interstellar space will have a small (but finite) probability of interacting with hydrogen atoms that exist in interstellar space. As small but finite quanta of photon mass is lost to the electrons, there is a reduction in photon momentum or energy. When such a photon arrives at our telescopes, we observe this phenomena as a red-shift. Currently we accept the red-shift as being due to the velocity of the source of the photons. Nearly all distant galaxies demonstrate the red-shift. Our current explanation is that all of these galaxies, **in every direction**, are moving away from us and the more distant the galaxy the faster it is moving away. **Therefore, we must be living in an expanding universe. If we accept this simple and easy to understand concept that photons from more distant stars give up more quanta of energy in their travel through interstellar space than do the photons from less distant stars**, the implications are the following: 1. The universe is not expanding. 2. The velocity of light may not be a constant (in line with experimental evidence). 3. The big bang is not needed. 4. The universe is relatively stable. **Remember that the major reason for the Big Bang is to give the universe the impetus for expanding.**"

Fox's idea to apply QMT for explaining the red-shift deserves to be more thoroughly elaborated. The idea is inspirational not only to search for the analytical support for such an application, but to set up new experiments which will verify the results of that analysis.

Before undertaking such an endeavor it is necessary to make a general assumption.

Let us assume that all objects in the universe which emit light, could be in two major states: either these objects are surrounded by gases in atomic or molecular state, or surrounded by plasma i.e., ionized gases. The combined situation should not be excluded.

The above assumption is not necessary only for the sake of simplification of the theoretical analysis, but also for the attempts to simulate some of those situations experimentally.

According to second QMT principle for photon-electron interaction, electron captures photon incorporating its mass. For Hydrogen atom it is expressed by the next equation [1] (ref. 1, p 19, Eq 37):

$$m_{el} = m_{en} + m_f - \Delta m_e \tag{1}$$

where m_{el} is the mass of the electron in the orbit l,

m_{en} - mass of the electron in orbit n,

m_f - mass of the incident photon participating in the interaction.

Δm_e - is magnitude which includes mass defect as result of fusion of two particles electron and photon, and effects which are result of atomic and vacuum properties predicted by QMT.

The third principle of QMT, for momentum conservation law, states [1] (ref. 1, p 20, Eq 40),

$$lm_{el}v_l = nm_{en}v_n + m_f c \tag{2}$$

THE ANALYSIS

We shall elaborate on the situation which has not been considered in ref. [1]: the photon-electron interaction, when electron is not part of the atomic system, i.e., when it is free. This task is easier for theoretical analysis but also easier to set up the corresponding experiment, than to consider gases in atomic state or plasma case, or even worse, the combination of them.

The essential idea is presented in the Fig. 1.

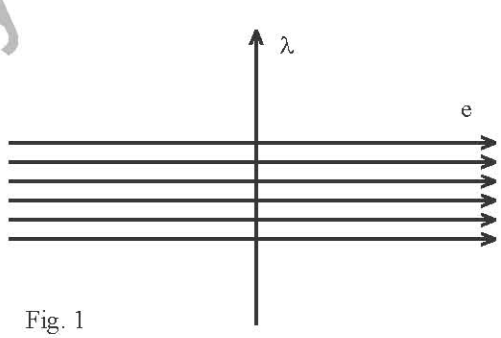


Fig. 1

Fig. 1 shows the electron beam *e* intersecting the light beam λ. The supposition is that photon-electron interaction will take place. We shall apply MESOF theory and QMT, to find out what could be the possible consequences of the interaction if certain conditions would be satisfied. That specific condition is presence of externally applied electric field. Before that, we shall consider the case presented in the Fig. 1, by using the Feynman diagram. Fig. 2, shows Feynman diagram presenting the whole process of photon-electron interaction, from the start, when a photon is captured by an electron to the final state, when the electron emits a photon.

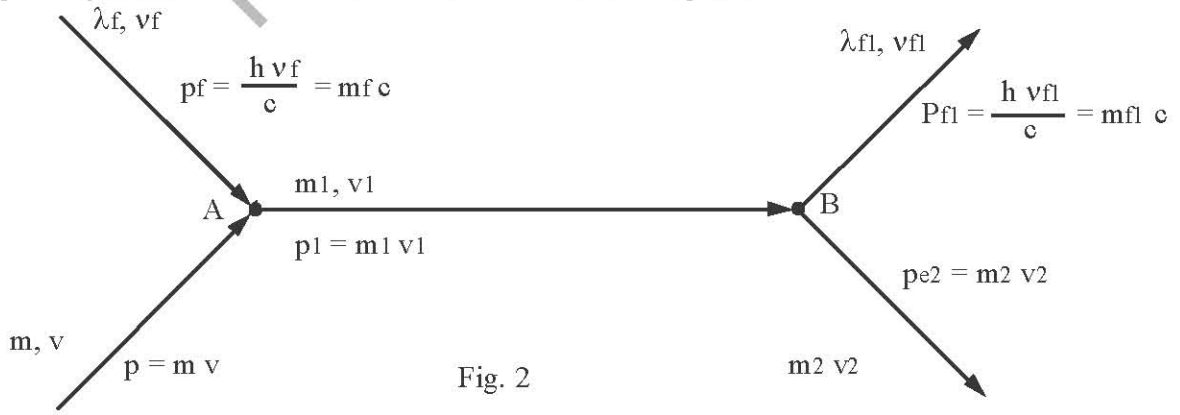


Fig. 2

For this case, presented by Feynman diagram in Fig. 2, the principal QMT equations will be used in order to describe the whole process of this photon-electron interaction.

According to Eq. (1) of the QMT mass conservation principle [1] (ref. 1, p 19, Eq 37), at point A, the mass of the electron would be,

$$m_1 = m + m_f - \Delta m_{e1} \tag{3}$$

and according to the QMT version of the law of momentum conservation,

$$m_1 v_1 = mv + m_f c \tag{4}$$

If, $\lambda_{f1} > \lambda_f$ and $\nu_{f1} < \nu_f$ hence, $h\lambda_{f1} < h\lambda_f$ yields,

$$m_{f1} < m_f \tag{5}$$

Then, in point B, the mass of the electron will be,

$$m_2 = m_1 - m_{f2} + \Delta m_{e2} \tag{6}$$

and the equation for the law of momentum conservation in point B will be,

$$m_1 v_1 = m_2 v_2 + m_{f1} c \tag{7}$$

As we have stated before, this is the case without presence of the external electric field.

The magnitude Δm_e according to QMT, consists of mass defect as a result of fusion of electron and photon masses, but also it includes the effects emerging from the new atom and vacuum properties, predicted by QMT. Because the state of the atom is determined by the principal quantum number n, then this magnitude, when atomic system is considered, is connected with this number. Here, the electron is free, therefore, magnitude Δm_e will be connected with magnitudes which will represent its state. When the case with presence of the externally applied electric field is considered, this will be defined.

Photon-electron interaction in presence of externally applied electric field.

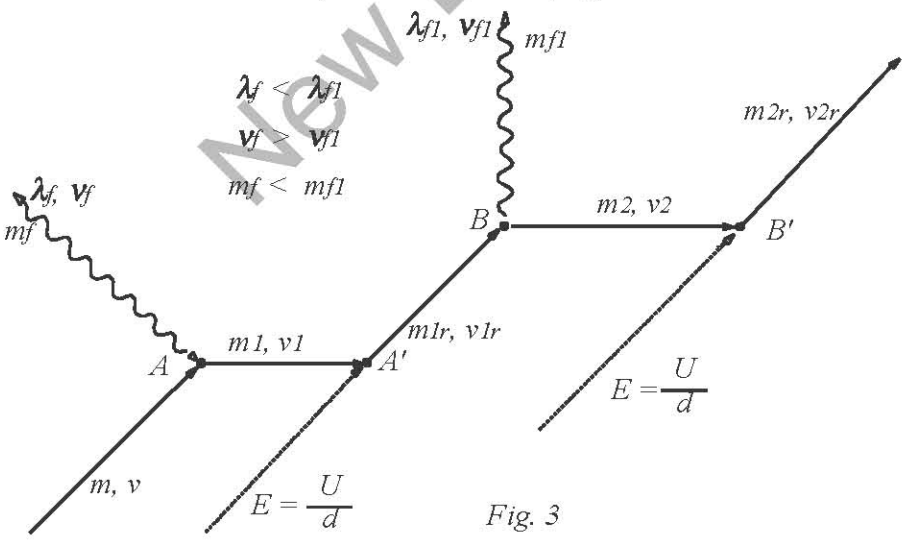


Fig. 3

In Fig. 3 is the Feynman diagram for photon-electron interaction when the electron is driven by the electric field,

$$E = \frac{U}{d}$$

As it is usually done with Feynman diagrams, the magnitudes and the angles between them, are out of scale, and the values are randomly chosen.

Point A

At this point the photon-electron interaction takes place which will be described by MESOF theory and QMT. The initial conditions which are necessary to be satisfied, in order to be able to apply these theories, will be determined by MESOF theory.

According to MESOF theory, the maximum effect in photon-electron interaction occurs if the frequency of the incident photon is resonant with de Broglie's waves of the electron. For an electron in the Hydrogen atom, the ratio

between the wavelength of the incident light, and the wavelength of de Broglie's waves of the electron in the radial position r^0 (Bohr radius) is [2] (ref. 2, p 152, Eq 108),

$$\Delta\lambda_r = \frac{2\pi\lambda}{\lambda r^2} \tag{8}$$

In our case for free the electron, the ratio between the wavelength of the incident photon λ_f and the wavelength of de Broglie's waves of the electron λ is

$$\lambda_f = \frac{n}{2}\lambda \tag{9}$$

where n is a positive integer.

By using de Broglie's equation,

$$\lambda = \frac{h}{mv} \tag{10}$$

where m is the mass of the electron moving with velocity v. Velocity of the electron under action of the electric field, $E = \frac{U}{d}$ is,

$$v = \sqrt{\frac{2eU}{m}} \tag{11}$$

where U is the voltage, d is distance and e is charge of the electron.

The relativistic mass of the electron is

$$m_r = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{12}$$

where m = 9.1085 • 10^{-31} kg is electron mass at rest.

EXAMPLE

Let us consider an experiment in which the light from a hydrogen discharge tube will be used. First of all it is necessary to choose a certain wavelength from the hydrogen spectrum which will be used in the experiment. After that, we have to find out what velocity the electron should have so that its de Broglie's waves will satisfy the conditions of the Eq. (9). Then, to determine the value of the externally applied electric field which will give the necessary velocity to the electron.

We shall take the line from the Hydrogen spectrum which represents the electron transition in the atom 2 - 6, with λ_f = 410.17 nm, ν_f = 7.314·10^{14} l/s and energy $h\nu_f$ = 3.024 eV.

By computing, it was found that electron will have velocity v = 3 • 10^7 m/s if the externally applied electric field is produced by the voltage U = 2614 V. Then the wavelength of its de Broglie waves will be λ = 2.4123 • 10^{-2} nm. The positive integer in the Eq. (9) then is n = 34006. This electron will interact most effectively with chosen wavelength of the incident light.

When the condition for maximum photon-electron interaction will be satisfied according to the MESOF theory for point A, then it is possible to apply the QMT principles for this interaction.

POINT A

We shall use the Eqs. (1), (2) and modify them for the case with free electrons in the electric field E. The analysis will be carried out by using the Feynman diagram presented in Fig. 3. The values of the magnitudes and the angles between them are also out of scale, and randomly chosen.

Hence, for point A, equation (1) becomes

$$m_1 = m + m_f - \Delta m_{el} \tag{13}$$

where, m - is mass of the electron in the electric field E produced by the voltage U,
m_1 - mass of the electron after interaction with photon with mass m_f,
m_f - mass of the photon with wavelength λ_f,
Δm_{el}- is magnitude which includes the mass defect as a result of fusion of these two particles, and effects which are the result of the state of the electron. The state of the electron is defined by the electric field E, i.e., by the applied voltage U.

The analysis shows that Δm_{el} is given by the expression

$$\Delta m_{el} = \frac{m_f}{\alpha}\left(\frac{v - v_1}{v}\right) \tag{14}$$

where,

$$\alpha = \frac{e^2}{\hbar c} = 7.297 \cdot 10^{-3} \tag{15}$$

is the fine structure constant, and $\hbar = h/2\pi$ where $h = 6.625 \bullet 10^{-34}$ J/s is Planck's constant.

Thus the Eq. (13) becomes,

$$m_1 = m + m_f - \frac{m_f}{\alpha}\left(\frac{v - v_1}{v}\right) \tag{16}$$

or,

$$m_1 = m + m_f\left(1 - \frac{1}{\alpha}\frac{v - v_1}{v}\right) \tag{17}$$

From the macroscopic point of view, the momentum of the electron in a distance A - A′ could be considered as virtual, not real. In the analysis, the electric field is taken into account, since it acts instantly, but the relativistic effect is ignored.

We shall make a distinction between these two possibilities, having in mind one of the basic principles: everything that is occurring in nature, is actually happening in a certain space and time. Not because it is convenient for the analysis, but mainly because our comprehension of these processes. We think that there must be a certain time and space for the electron to gain mass according to QMT principles. There also must be a certain time and space before the electron can gain the relativistic mass, regardless of how small the values of these magnitudes could be in both cases.

Hence, for point A, we shall apply the third principle of QMT for momentum conservation law which is given here by Eq. (12). This equation modified for free electron will be

$$m_1 v_1 = mv + m_f c \tag{18}$$

Thus, electron with mass m_1 will arrive in the point A′ and it starts to gain relativistic mass,

$$m_{1r} = \frac{m_1}{\sqrt{1 - \frac{v_{1r}^2}{c^2}}} \tag{19}$$

where,

$$v_{1r} = \sqrt{\frac{2eU}{m_{1r}}} \tag{20}$$

POINT B

Hence, electron with mass m_{1r} will arrive at point B. At this point, the electron emits photon with λ_{f1} and ν_{f1} and mass m_{f1}. The energy of the emitted photon is

$$h\nu_{f1} = m_{f1}c^2 \tag{21}$$

The electron loses a fraction of its mass and energy as a result of its disintegration, caused by emission of the photon.

The second principle of QMT applied for point B now, gives the mass of electron after emission of the photon with mass m_{f1},

$$m_2 = m_{1r} - m_{f1} + \Delta m_{e2} \tag{22}$$

where Δm_{e2} is the magnitude which includes the necessary energy to cause disintegration of the electron, equal to mass defect, and effects emerging from the property of the electron as a result of its state. In this case, the state of the electron depends only on the applied electric field E. When initially, QMT was applied to the atomic system, for instance to the hydrogen atom, the magnitude Δm_e was described as the magnitude which represents the mass defect, as a result of photon-electron integration, plus the effects emerging from the new predicted atom properties. Those new predicted atom properties by QMT, are explained as a result of the vacuum polarization caused by both particles: proton and electron. In this case, when free electron is considered, Δm_{e1} represents both mass defects and effects caused by the vacuum polarization interaction with the electron. The same definition is valid for Δm_{e2} and results of the analysis show that for given electric field, acting on the electron, stands the next equation

$$\Delta m_{e1} = \Delta m_{e2} \tag{23}$$

but only numerically. At point B, Δm_{e2} is given by the expression

$$\Delta m_{e2} = \frac{m_{f1}}{\alpha} \frac{v_{1r} - v_2}{v_{1r}} \tag{24}$$

Thus, Eq. (22) becomes

$$m_2 = m_{1r} - m_{f1} + \frac{m_{f1}}{\alpha}\left(\frac{v_{1r} - v_2}{v_{1r}}\right) \tag{25}$$

or

$$m_2 = m_{1r} - m_{f1}\left(1 - \frac{1}{\alpha}\frac{v_{1r} - v_2}{v_{1r}}\right) \tag{25a}$$

From point B to point B′, there is movement of the electron again which macroscopically can be considered as virtual, but again we shall consider it as real phenomenon. Hence, the electron with mass m_2 will arrive at the point B′ with velocity

$$v_2 = \sqrt{\frac{2eU}{m_2}} \tag{26}$$

but again there will not be relativistic change of the electron mass.

Now, Eq. (2) for momentum conservation law applied to point B is

$$m_{1r} v_{1r} = m_2 v_2 + m_{f1} c \tag{27}$$

The electron gains the relativistic mass at point B′.

$$m_{2r} = \frac{m_2}{\sqrt{1 - \frac{v_{2r}^2}{c^2}}}$$

moving with velocity

$$v_{2r} = \sqrt{\frac{2eU}{m_{2r}}}$$

In the analyzed photon-electron interaction process, an electron captures a photon by incorporating its mass, performs two "virtual" movements and at the end, emits the photon with bigger wavelength,

$$\lambda_{f1} > \lambda_f$$

and with less energy,

$$h\nu_{f1} < h\nu_f .$$

CONCLUSIONS

During the process elaborated here, considerable transformation of the electron mass, i.e., of the electron total energy is taking place. The analysis shows the next chain of electron mass transformations:

$$m < m_1 , m_1 < m_{1r} , m_{1r} > m_2 , m_2 < m_{2r}$$

with final results

$$m_2 > m$$

It means that the electron has gained mass as a result of an interaction with photon and action of the electric field. In other words, they are the **sources** where the gain of the mass and the energy are coming from. This was explained by Special Theory of Relativity and by Quantum Mass Theory.

In the described photon-electron interaction, the result is the electron with bigger mass and energy, and photon with less mass and less energy, and longer wavelength. The fact that a photon with longer wavelength is an outcome of the interaction does not have to be connected with Compton effect where similar effect is observed: the wavelength of deflected photon is longer than the one of the incident X-ray photon. There is a big difference between these two phenomena. Let us remind ourselves that in the Compton effect, the change of the wavelength depends only on the angle of incidence of X-ray beam. Here, the change of the wavelength of the incident photon depends on the state of the interacting electron only, determined by the externally applied electric field. Using the terms of QMT, the change of the photon mass depends on the vacuum polarization created by the participating electron.

Equations obtained by the presented analysis can be used for numerical computations, for example, when certain wavelengths of the incident photons and the electrons in a certain state are determined. The numerical computation has been done to determine the initial conditions necessary to satisfy the MESOF theory principles for a given example. The same example can be used to carry on the numerical computations to the end of the whole described process.

The presented analysis gives theoretical support to Fox's idea by the application of QMT to explain the cosmic red-shift. However, this could have another interesting application in astrophysics and astronomy.

It is well known that there are objects in the universe from which we detect microwaves. These microwaves could originate from the processes developing in the considered universal objects. However, if the presented analysis is

used, with addition of the second Fox's assumption, i.e., "The velocity of light may not be constant," then, microwaves we detect could be the result of X-ray transformations similar to the photon transformations described here. Quantum Mass Theory [1], applied to hydrogen atoms, shows what the mechanism is for emission of X-ray and γ-ray photons from that atom. Thus, there are X-ray photons which may transform to microwave photons if those X-ray photons interact with electrons which satisfy certain conditions.

At the end, we have to offer an explanation for the possibilities for emission of a photon with certain energy from the electron in the considered condition. In this case there should be nothing new. When and why an electron emits the photon is very well explained by the valid theory. What we need to explain is, why the emitted photon should have a longer wavelength compared to wavelength of the incident photon. If this question is put in another form: why the emitted photon has less mass, i.e., has less energy compared with mass and energy of the incident photon, then maybe it will be easier to explain and comprehend this part of the described process.

The beauty of this problem, initiated by Hal Fox, is the possibility to be experimentally verified.

In the next section, two possible experimental set ups for verification of the results of the presented analysis are considered.

EXPERIMENTS

Experiment No. 1.

In Fig. 4, the set up of the experiment with main apparatus designated with P, is presented. This apparatus consists of K - cathode, A - anode with voltage U; the electron beam goes through anode A and ends up on anode A_1 with voltage $U_1 > U$. The difference $U_1 - U$ should be small. The electron beam is passing through combined electric field E_1 and magnetic field with magnetic flux density B_1, so that

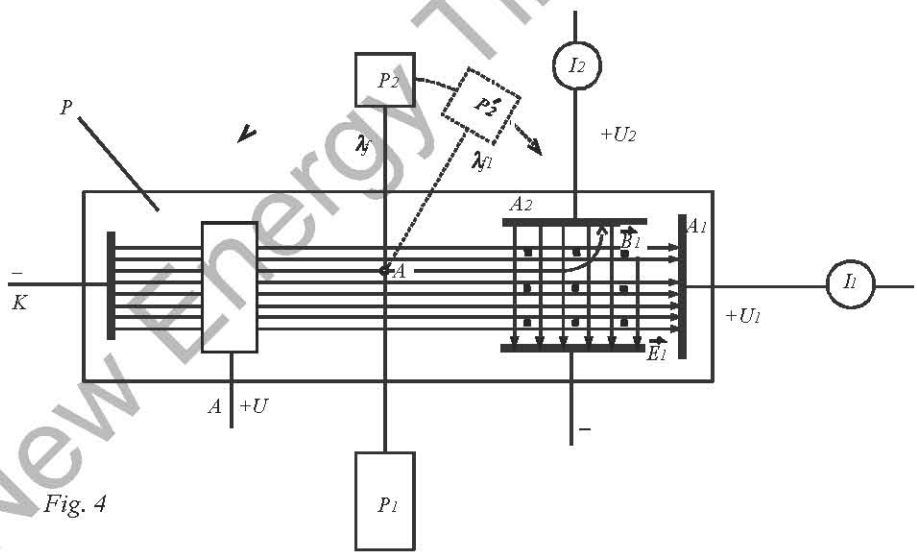


Fig. 4

$$v = \frac{E_1}{B_1}$$

where v is velocity of the electron which passes through both fields. The possibility should be considered of certain kinds of clusters to be used here [4].

An electron after interaction with photon gains the mass and its velocity drops: $v_2 \ll v$, hence, it cannot reach anode A_1, diverts from its trajectory and ends up on the plate A_2 with voltage U_2. Supposing that there will be much more electrons than one, which will undergo the described transformations, then current I_1 will decrease, and the increase of current I_2 will be registered. P_2 is an energy spectrum analyzer in the range of the wavelengths of the light used.

The energy spectrum of the light used will be measured first, when there is no electron beam (or high density charge clusters [4]) in the vacuum tube, and after that when electron beam (clusters [4]) and electric field E are present. The measured spectrums should be compared. However, the detector of the spectrum analyzer should be moved radially for the search of the deflected photons and to measure their energy and consequently their λ and ν. In

certain position, designated by P_2', the analyzer should detect the photon with wavelength: $\lambda_{f1} > \lambda_f$, according to the results of the analysis.

By measuring I_1, I_2 and energy spectrum of the light passing through the electron beam (cluster), it will be possible to verify the results of presented analysis for photon-electron interaction under the assumed conditions.

In order to enhance the effect, so that bigger I_2 and smaller I_1 will be registered, the arrangement with reflectors for the light could be used. In the Fig. 5, is presented the arrangement with several reflectors R which make the light cross the electron beam several times, in order to increase the probability for photon-electron interactions.

There are many possibilities as to what kind of light source could be used. We shall mention only two. It would be very convenient to use hydrogen discharge tube, because it provides the spectrum which can be used for numerical computations using the equations obtained by the presented analysis. The other possibility would be the use of the multimode laser. It is necessary for the laser to be multimode because there should be photons with λ different from λ_f of the captured photon by electron, which will "trigger" the emission of the photon λ_{f1}.

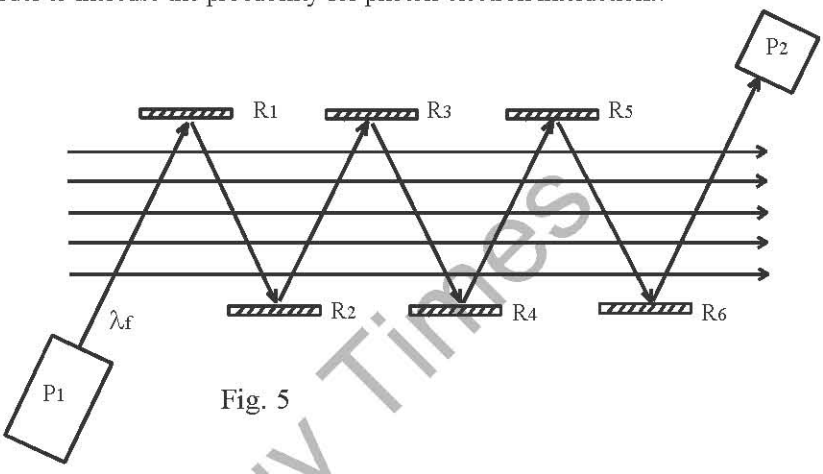


Fig. 5

Experiment No. 2

In this experiment, for verification of the photon-electron interaction analysis, completely different arrangements will be used.

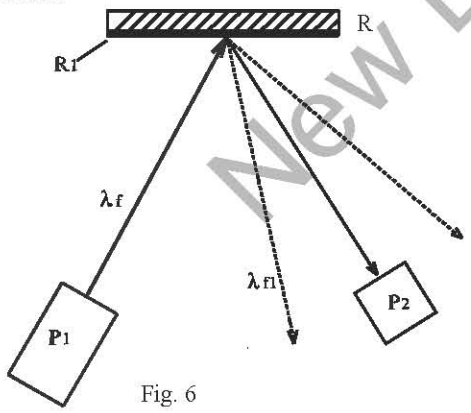


Fig. 6

In Ref. [2] (pp 142 - 173), the possibility for electronic magnetic resonance for optical frequencies in the atom, is elaborated. In Ref. [2] (pp 51 - 58), the results which show the possibility for experimental proof of the electronic magnetic resonance for optical frequencies in atoms, are presented.

In Fig. 6 is shown only the principle set up for the experiment.

R stands for the sample with reflecting layer which could be for instance TiO_2 (ref. 2, p 53, Fig. 9). However, some other materials could be used as well.

As the result of the effects described in both references, there should be dispersed light with wavelengths different from the wavelength of the incident light, and detected by spectrum analyzer P_2. P_1 stands for the light source.

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IS THE REDSHIFT A QUANTUM EFFECT?

Colin Walker[1]

ABSTRACT

The galactic redshift may correspond to the loss from light of a constant, universal quantum of energy per cycle, independent of the wavelength. A gravitational mechanism is considered.

QUANTIZATION OF ENERGY LOSS FROM LIGHT

In the 1920's, Hubble discovered that light which has travelled galactic distances is shifted to the red by an amount proportional to the distance travelled. In modern big bang interpretations of this phenomenon, the shift is caused by the expansion of the universe which results in a relative velocity of recession, $v = Hs$, where H is Hubble's constant and s is the distance to the galaxy. This apparent velocity of recession is inferred from the measurement, $\Delta\lambda$, of the shift in the wavelength of a known spectral line from its expected value, λ_0, using the Doppler approximation, $v \approx c\,\Delta\lambda / \lambda_0$, where c is the speed of light.

The alternative **tired light hypothesis** is that distant objects are relatively motionless and that their light is somehow losing energy along the way. Hubble and Tolman [4] show that the energy would decrease exponentially with the distance travelled by the light. Another way to examine this possibility is to determine the amount of energy lost by a photon in travelling its own wavelength. The observed shift in wavelength of light which has travelled a distance, s, can be expressed as

$$\Delta\lambda = \lambda_0 H s / c, \tag{1}$$

where λ_0 is the wavelength of light at the source. The expected change in wavelength of a photon which has travelled a distance equal to its own wavelength can be seen using equation (1) with $s = \lambda_0 + \Delta\lambda$ to be

$$\Delta\lambda = H\lambda_0^2 / (c - H\lambda_0)\,. \tag{2}$$

The energy of the photon at the source is hc / λ_0, where h is Planck's constant. In travelling its own wavelength, the photon loses an amount of energy, ΔE, as it falls to $hc / (\lambda_0 + \Delta\lambda)$. Using $\Delta\lambda$ from equation (2), the energy lost in one cycle is exactly

$$\Delta E = Hh. \tag{3}$$

Therefore, the hypothesis that all photons lose the same amount of energy in each cycle could also account for the observed redshift.

This is likely to be among the least energetic of interactions, and raises the possibility that light is quantized in increments of Hh, as in a quantum mechanical harmonic oscillator, with a zero-point energy of $Hh/2$ as the lowest energy state. It is necessary to distinguish between two theories of the interaction: the collision model of Broberg [1], and the emission model of Dart [2].

Broberg views the quantum energy as a standing wave across the diameter of a black hole which corresponds to our universe, with the redshift arising from interactions between photons and these **elementary quanta**. In a variation of Broberg's model, a photon and a **photino** (a name coined by Dart) meet head on in an elastic collision. Consider a photon travelling forward with momentum, E/c, and a photino of energy, $Hh/2$, coming towards it with momentum $-Hh/2c$. After the collision, the photino rebounds with momentum $Hh/2c$ resulting in a combined change in momentum, Hh/c, lost from the photon. The total momentum of the system remains unchanged. The energy of the photon decreases by Hh, which is the energy required to reverse the direction of the photino.

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Dart reasoned that in each cycle, a photon would release two photinos. Assuming they have positive energy, the photinos must be emitted ahead of the photon for conservation of momentum to be satisfied. Alternatively, an entity with negative energy could be absorbed or emitted by a photon.

There are clues to indicate that the underlying cause of the redshift is gravitational, implying that the quanta involved are gravitons. The photon is known to possess integral spin while the angular momentum of the graviton is supposed to be double that value.

SCATTERING

If the redshift is due to the loss of energy from light, then smearing of the images of distant objects should occur as a result of the scattering of photons as they lose momentum. The momentum of the photon is given by $p = E/c = h / \lambda$. The change of momentum in each cycle is $\Delta p = \Delta E / c = Hh / c$, so that the scattering angle is at most $\theta = \Delta p / p = H \lambda / c$. A demonstration of the expected smearing is provided by the following example. Consider a photon with wavelength, $\lambda = 10^{-7}$ meter, emitted from a distant object with redshift $\Delta \lambda / \lambda \approx 0.1$, corresponding nearly to a number of cycles, $N = 10^{32}$ -- i.e., a distance of roughly $N \lambda = 10^{25}$ meters. For this wavelength, the maximum scattering angle is $\theta = 10^{-33}$ radian per cycle. The worst-case estimate of the total scattering angle, $N \theta = 0.1$ radian, occurs if all deflections are assumed to be, for instance, to the left.

In the parlance of quantum field theory a photon has two degrees of freedom, meaning that changes can only occur in the two dimentions perpendicular to its path. A much smaller estimate of the total scattering angle is obtained by assuming that deflections to the left occur with the same probability as deflections to the right. The natural analogy here is to decide which direction is taken on the basis of flipping a coin, in the manner of Bernoulli trials. Let k be the number of heads which occur in N tosses of the coin. The variable $k^* = 2(k - N/2) / N^{1/2}$ is standardized normal -- i.e., k^* has zero mean and unit variance, and is from the normal distribution. This enables statements to be made concerning the probability of deviations of k from its mean, $N/2$. For instance, $k^* = 3.88$ corresponds to $1\text{-}F(k^*) = 0.0001$ from the cumulative normal distribution. This means that 99.98% of sequences of N tosses are expected to yield less than $k^* N^{1/2} /2 \approx 2 \times 10^{16}$ surplus heads. The total angle of deflection corresponding to this surplus is $2 \times 10^{16} \theta = 2 \times 10^{-17}$ radian. At a distance of 10^{25} meters, this arc subtends a distance of 2×10^{8} meters, or about one quarter the size of the sun. From this, it can be concluded that smearing due to scattering would be unobservable.

GRAVITATIONAL MODEL OF THE ENERGY LOSS

A static model of the universe is the natural framework in which to consider the redshift as loss of energy from light. Cosmological models generally ignore the granular character of the distribution of matter throughout the universe by assuming a homogeneous distribution in which tidal forces do not exist. This stands in contrast with the fact that matter is rather dense, and occupies a very small proportion of space.

To obtain an idea of the possible error introduced by the simplifying assumption of a uniform distribution, let us take an extreme example of granularity in which the matter in a spherical region of space is concentrated equally at the centroids of two hemispheres. For a spherical region of radius R, the centroids will be located along a diameter at coordinates $-X$ and $+X$, where $X = 3R/8$. Given the mean density, ρ, the mass of each hemisphere will be $M = 2 \pi R^3 \rho / 3$.

Consider the tidal effect of the centroids on a pair of identical test particles, each of mass $m << M$, located near the center of the spherical region at coordinates $-x$ and $+x$, where $x << X$. Ignoring their mutual attraction, the distance between the test particles will tend to increase since the particle at $+x$ will experience a force

$$f = \frac{GMm}{(X-x)^2} - \frac{GMm}{(X+x)^2} \approx \frac{4GMmx}{X^3} \tag{4}$$

where G is Newton's constant of gravitation, and the particle at $-x$ will experience a force of the same magnitude in the opposite direction. This orientation of the test particles produces the maximum magnitude of the tidal effect. Other orientations can reverse the effect by causing the particles to move towards each other. Substituting for M and X yields the equation of motion with respect to time for the test particle at $+x$ as

$$\frac{d^2x}{dt^2} - k^2x = 0 \tag{5}$$

where $k^2 = (8/3)^4 \pi G\rho$. This Newtonian result is conveniently independent of the radius of the spherical section. While it can be shown that the homogeneous distribution of matter leads to cancellation of the tidal effect, any other distribution will exhibit systematic bias.

The solution to equation (5) describing the expansion of equivalent mass comprising a photon is

$$\lambda = \lambda_0 e^{kt}, \tag{6}$$

where t is the time of flight. Here, it is assumed that the distribution of equivalent mass of the photon can be considered as a pair of test masses. It can be inferred from its angular momentum that the photon is not a point, so that its equivalent mass may be susceptible to the tidal force. It is also assumed that there is no gravitational attraction between parts of the same photon.

By taking the derivative of equation (6) with respect to time, the photon's change in wavelength is seen to be related to its time of flight by

$$\Delta \lambda \approx \lambda_0 kt, \tag{7}$$

for $kt << 1$. Comparing equations (1) and (7), it is seen that this Newtonian tidal model of the redshift yields Hubble's law if $k = H$, a relation which is numerically plausible. It follows that the premise of energy loss from light is consistent with a classical prediction of continuous energy loss.

It is interesting that the recession hypothesis predicts an acceleration between objects which is indistinguishable from the acceleration due to tidal repulsion. Consider the equation for recessional velocity, $v = Hs$. The velocity measured one second later would be $u = H(s+v)$, revealing an acceleration of $u\text{-}v = H^2s$. This is identical to the tidal acceleration, k^2x, of equation (5) after substituting $k = H$ and $x = s$. It seems that a tidal force fits either hypothesis of the redshift.

There is a plausible connection between such a residual tidal effect, and the cosmological constant introduced by Einstein [3] to ensure that the equations of general relativity are consistent with a uniform distribution of matter which is both finite and static. The cosmological constant depends on the density, and defines the radius of a universe without boundaries. The cosmological term effectively cancels the acceleration expected from the recession hypothesis. The connection becomes apparent when the value of $k^2 = (8/3)^4 \pi G\rho$ in equation (5) is compared with $4\pi G\rho$, the value of the cosmological constant.

In a static universe, galaxies might be assumed to have attained equilibrium positions with the forces of attraction and repulsion in balance. Consider the forces of gravitational attraction and tidal repulsion on the pair of test masses separated by $2x$. Gravitational attraction dominates for short distances, and tidal repulsion dominates for large distances. The forces are balanced when

$$\frac{Gm^2}{4x^2} = 2k^2mx \ . \tag{8}$$

Pursuing the connection to the cosmological constant by setting $k^2 = 4\pi G\rho$ results in a limiting distance, $2x$, for the influence of gravitational attraction given by

$$(2x)^3 = \frac{m}{4\pi\rho} \ . \tag{9}$$

Pairs of test particles of mass, m, separated by more than $2x$ will experience a force which tends to increase their separation. The tidal force should diminish eventually with increasing distance due to the attraction of intervening matter on the test masses. By creating separate gravitational spheres of influence, the same tidal mechanism underlying the redshift of light may also be associated with the relative isolation of galaxies and stars.

TOWARDS A QUANTUM COSMOLOGY

Einstein was initially troubled by the singularities which occurred in his general theory of relativity because the theory breaks down at those points, but reluctantly came to accept singularities, and attempted to exploit them, as Broberg has done, to predict the elementary particle masses. The giant stars in the center of galaxies provide conditions which test the prediction of black hole singularities.

Dart finds that experimental evidence can be interpreted to show that time is altered in a gravitational field, but space is not, and therefore it is a mistake to consider a closed universe. His scalar field theory satisfies the observational tests of relativity, and avoids the singularities predicted by general relativity. For objects like galactic superstars, Dart's theory predicts that the force of gravity is reversed within approximately the Schwarzschild radius, leading to an outward pressure within the star. Interestingly, many of these giant stars have jets of matter being ejected from one, or both, poles. As Dart points out in support of his theory, the poles of a rotating star would have the least inward pressure, and would be the most likely places to allow matter to be expelled from the interior.

Shortly after Einstein introduced general relativity and his cosmological model, Kaluza found that the theories of general relativity and electromagnetism can be united in a space of 5 dimensions, the extra dimension being spatial. Klein then showed that the fifth dimension would be compressed into a tiny circle, far too small to be observed.

There is a deep connection between quantum field theory and the structures of modern algebra, so mathematics may be a guide here to physics. It is relevant to quantum field theory to note that the complex number field describing a photon forms a division algebra in 2 dimensions, a fact which has long been known. In the 1840's two other division algebras were found. The 4-dimensional space-time of general relativity was discovered by Hamilton to form a division algebra known as a quaternion, and Cayley found the only other division algebra, the octernion, which requires 8 dimensions. In 1940, Hopf showed that a division algebra requires that the number of dimensions be a power of two. It was not until 1955 that Toda showed there is no division algebra for 16 dimensions, and by the end of that decade it had been proved that no other division algebras exist.

To form an octernion division algebra for cosmology, symmetry requires the addition of 3 time-like dimensions to the 5 dimensions of Kaluza's theory. In this 8-dimensional quantum field theory, a dual universe, having the roles of space and time reversed, would coexist with the 4-dimensional universe we perceive.

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EDITOR'S NOTE: The reader should compare this paper with the paper by Anastosovski et al., elsewhere in this issue. Anastasovski delineates the mechanism to support the "tired light hypothesis."

MISCELLANEOUS

ON THE ILLUSION DERIVED FROM TIMELESS SYSTEMS

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ABSTRACT

There is a notion among contemporary physicists that time can be dilated or caused to be longer to stationary observers watching systems in motion. The Italian astronomer and physicist Galileo Galilei, pointed out that if a ship, say, is moving in a harbor and an object is released from the mast of the ship, the object falls straight down and hits the deck near the base of the mast, as observed on the vessel. But if such observation is taken from the shore, the object will not appear to fall straight down. According to Galilei, from the shore the object will be seen following a parabolic path. He reasoned that the falling object must maintain its forward motion because the ship is carrying it along, while simultaneously it falls toward the Earth. However, it is well known that regardless of outside observation, the falling object will still hit the deck at the foot of the mast simply because the ship is moving along and keeping pace with the forward motion of the falling object. Yet, if a sailor on the shore and a sailor on the ship were to have identical clocks, the former will **see** that the falling object takes longer to fall, relative to the time measured by the sailor on the ship. This is a classical case demonstrating time dilation as accepted by mainstream physics today. But this author will show that time dilation must be an illusion occurring to a stationary observer watching moving points of interest along static and therefore timeless trajectories or paths.

INTRODUCTION

A portion of relativity theory concerning the celebrated time dilation problem has recently been brought to my attention. Albert Einstein proposed that time intervals between separate events will be measured differently in different moving systems. He proposed that two identical clocks must run at different rates when they are located in these different moving systems. That is, according to Einstein and his followers, the time given by these clocks will be different. Some modern observers however, seem to doubt the validity of this time dilation possibility. And I must say that after careful consideration, I must add myself to the latter group.

TIME DILATION OBSERVED

The Einstein time dilation assumption can be illustrated by the classical example of the mirror clock. A moving system contains a mirror and a box containing a light source and having a coverable hole. The light source can produce a beam through the coverable hole. The light beam is allowed to travel to the mirror which is located above the box and 93,000 miles away. Assuming that light travels at 186,000 miles per second, we get that the time travel for this beam from the box to the mirror is point five seconds. While having an equal return time, this light beam returns to the hole on the box one second later. Thus, we know that this mirror clock is a one-second timing clock. An observer standing on this moving system can confirm this as seen above in Fig.1, where (P1) is a stationary observer relative to (a). Having two such clocks, whereonecouldbeplaced in moving system (a), and the other in moving system (b).

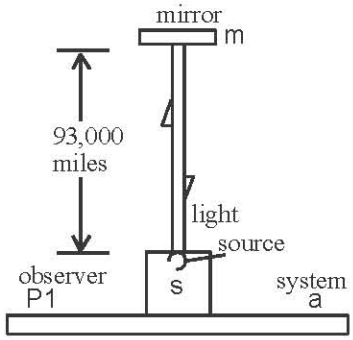

Fig. 1 One Second Clock

The two moving systems are assigned to travel in opposite directions and at constant velocity relative to each other. As seen in its own moving system, each clock works according to expectation. However, it is assumed that as seen from the other moving system, each clock runs slower than expected. This is the phenomenon Einstein called time dilation. The depiction of it is shown in Fig. 2. We arrange it so that the clock in moving system (a), as seen from

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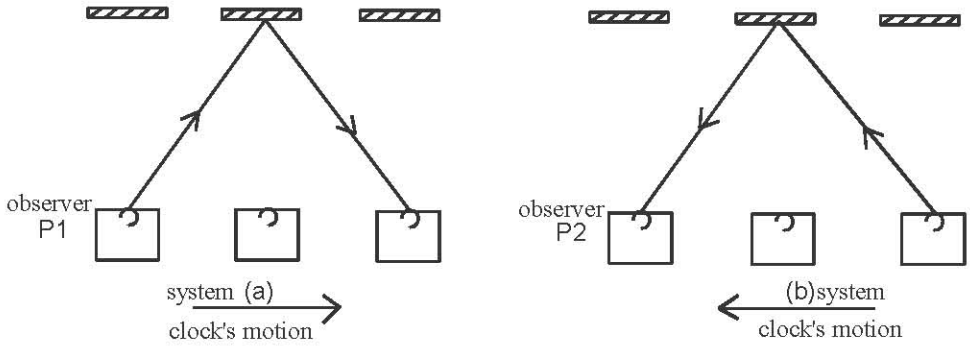


Fig. 2 Clocks viewed from systems with relative motion

(b), moves with speed v. During the half-second it takes the light beam to travel from the hole in the box to the mirror, the mirror has moved to the center position. Einstein and his followers believe that as seen from moving system (b), the light beam has traveled upward along a diagonal path until it was reflected, then downward along another diagonal path. Again, the whole picture is envisioned as seen on Fig. 2. Einstein tell us that to an observer in moving system (b), the light beam in the clock of moving system (a) has traveled a greater distance than the beam of light in his own stationary clock. Einstein further sustains that the time interval between the two events -- the light beam leaving the box, and the light beam returning — is not one second for the moving clock, and relative to the observer in the other moving system, but some longer time. In other words, Einstein proposes that for the stationary observer, the moving clock runs slow!

A POINT OF INTEREST IN THE PRINCIPLE OF RELATIVITY

Does the clock in moving system (a) slow down relative to an observer in moving system (b)? Is there really time dilation? Let us investigate. The principle of relativity states that we cannot detect our own motion except when relative to some other object. This brings the proposition that time must be the product of relative motion. This proposition tells us that if a system is not describing motion relative to something, then time for said static system must be non-existent.

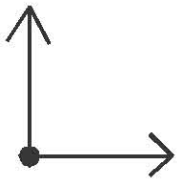
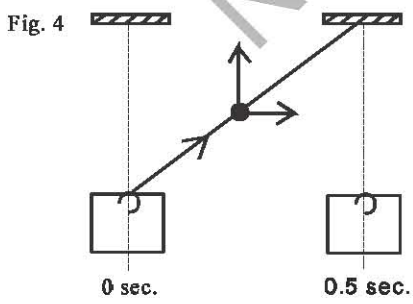
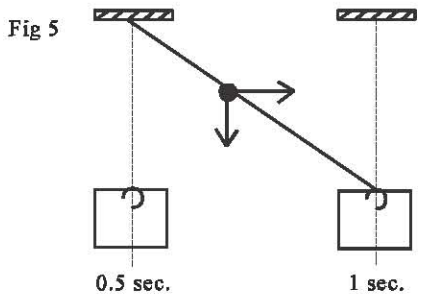


Fig. 3

In Fig. 1 we saw that in moving system (a), observer (P1) sees his light beam describing a straight line going up and coming down. One must treat this light beam as a "light line," if you will, having a point of interest to any observer, it being the beginning of the light beam. Observer (P1) though cannot see that this light line is moving in the direction that the box producing it is moving. In short, he can see that the light line of moving system (b) is describing a diagonal path while accepting that his own light line can only move straight up and down.





Observer (P2) in moving system (b) has exactly the same problem of observation. As a result they believe that the other's clock runs slow. So, since the accuracy of these mirror clocks depend on the motion of the points of interest of the light lines, we must search in this area of the experiment. Observer (P2) assumes that at the beginning of the experiment the point of interest of light line (a) is describing dual motion; it is moving up, and also in the direction of motion of moving system (a). The depiction of this idea is shown above in Fig. 3. If we plot this motion we get Fig. 4. Observer (P2) further sees that on the way down the point of interest of this light line will describe a

dual motion such as the one depicted in Fig. 5. For the total trip of the point of interest of light line (a), we get a representation such as the one given in Fig. 6.

Fig. 6

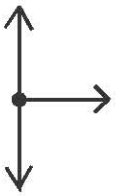


Fig. 7

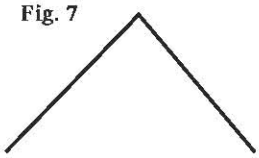


Fig. 6 tell us that we have light line (a) having a point of interest describing various types of motion relative to observer (P2). Now let us consider the trajectory taken by the point of interest of light line (a). For the total length of its trip we get a depiction just like Fig. 7. If we isolate the motion of the point of interest from its apparent path, we get **a static diagonal path**. Please notice that no motion can be associated with the isolated diagonal path even when it is reinstated into the experiment. Observer (P2) must agree that during the motion period of (P1)'s mirror clock, the path taken by the point of interest of light line (a) is a static system; the path never really moves! Since motion is missing in Fig 7, time cannot take place in this picture. In other words, the path of the point of interest of light line (a) is a timeless system. These results tell us that it is meaningless to assign time to absolute rest. Also we see that, in reality, for a stationary observer a point of interest in a moving imaginary line will also move via a static path. Where said path must be considered a timeless system describing absolute rest. As a direct consequence we get the four laws of timeless systems. They are:

(1) For a stationary observer, a point of interest in a moving imaginary line will also move via a static path.
(2) A static path must be considered a timeless system describing absolute rest.
(3) Absolute rest is timeless, and
(4) Time cannot be dilated.

In conclusion we learn that time dilation must be an illusion for a stationary observer watching moving points of interest along timeless routes.

EDITOR'S NOTE: The reader should be aware of the fact that several international organizations are holding conferences in which serious scientific papers are being presented concerning the validity of some of the concepts in Special and General Relativity. One of these is the Natural Philosophy Alliance in the U.S. This Journal expects to publish selected papers that bear on relativity and energy.

POTENTIAL IN SPACE OF COMPOUND CURVATURE

Howard Hull

ABSTRACT

In a paper titled "Potential in Space of Negative Curvature" by Laurence Hecht (*Research Communications*, Winter 1992) the geometry and calculus for treatment of the Pseudosphere as a description of Mass-Energy transfer and nuclear particle repulsion was developed. While the paper was cleverly written and stimulating with respect to the disciplines of potential mapping and relational thinking, many things are suggested concerning which further work needed to be done.

In some speculative work regarding possible toroidal geometries as a better solution than pseudospherical geometry for the problems at hand, Ron Kovac pointed out that the Meusnier Transform cited and explained in Hecht's paper was also applicable to toroidal geometry. Kovac cited several other works which effectively used toroidal configurations to depict geometrical approaches to electrodynamic applications. Further, it was noticed by the author of this paper that the toroidal geometry has pseudospherical interior surfaces, and, as Kovac entreated, could be subjected to the same sort of analysis. Indeed, this analysis can be done; this paper develops Hecht's morphology of the pseudosphere in application to the toroid.

PART I: TOROIDAL POTENTIAL

In order to derive relationships for the toroid like the ones derived for the pseudosphere by Laurence Hecht, we need to work like Hecht:

The inverse square law for force is written $F = dV/dr = 1/r^2$ where V is a potential at some point in a field and r is the radial distance from a source, or center, as it would appear, of attractive potential. One gets back to potential from force by integrating over distance from the source. Hecht's pseudospheric surface has a front and a back radius of curvature, so $V = \int (1/rr')dr$ (leaving aside the constant of integration, which is needed only to handle any offset that might be brought about via a non-zero boundary for the integral). It should be pointed out that most point potential functions cannot be integrated from a zero boundary, as the zero bound contains a singularity (1/0). Thus a range is specified for the integral, and the singularity is normalized away by subsequent operations (such as computing a suitable constant of integration via volume/energy relationships involving a conservation law).

The potential here has a geometry involving force exerted along a path and is one in which work (a change in potential) can be done to move a **test particle** from some preferred position or trajectory. Earlier study by the first electrodynamicists revealed that the curvature of a **surface** of constant potential was equivalent to the force required. The sphere is an object with a surface of constant positive curvature, and is useful in describing force fields derived from a point source. Positive curvature is associated thereby with an attractive source.

Hecht, in his paper, summarized the work of Gauss and Beltrami in their description of the Pseudosphere, an object with constant negative curvature. The description entertains a number of geometrical figures to verify the properties of the pseudospherical field, namely, that it also is sourced at a singular point, but, and perhaps surprisingly, it is not a completely symmetrical object, having an axis of rotation and an evolute sheet of infinite extent (the catenoid). As such, what the sphere is to spherical trigonometry and circular functions, and to travelling waves, the pseudosphere is to the realm of hyperbolic trigonometry, hyperbolic functions and stationary waves of the Klein-Gordon formulation. [1] The pseudosphere has constant negative curvature, and is useful in describing repulsive force fields derived from a point source. Summarizing:

1. Hecht notes that for the sphere, the inner sheet is collapsed to a point, while the outer sheet is expanded to the entire extent of the surrounding outer space. For the pseudosphere, Hecht develops a description in which the inner sheet is an infinitely long line (the pseudosphere's axis) and the outer sheet becomes a catenoid. Thus, unlike the sphere, the pseudosphere is a spatially polarized geometrical object. For the toroid, though, the inner sheet is expanded from the sphere's point to a circle of radius R_o and the pseudosphere's line axis is preserved as the axis of the toroid. The toroid's external sheet is the same as the sphere's, and thus consists of the extent of the

surrounding outer space. As such, the toroid may be realized as the geometrical superpositioning of the sphere and the pseudosphere. The extent of outer space and the circle make up the outer and inner sheets, respectively, for the outer positive curvature surface, and the circle and the axial line make up the outer and inner sheets, respectively, of the inner negative curvature surface.

2. The expression for the force ($dV/dr = 1/r^2$) is equivalent to the Gaussian curvature of a sphere of radius r. For the sphere, the force is everywhere positive, since the two radii of curvature are on the same side of the surface, radiating as they do from the center of the sphere. The sphere has constant positive curvature; the length of the radii of curvature are everywhere equal, having a magnitude equal to the radius of the sphere. For the pseudosphere, the curvature is $dV/dr = -1/rr'$. The product rr' is retained at a constant value everywhere, because as the length of the normal to the catenary (which generated the catenoid sheet via rotation) increases, the length of the normal from the tractrix (from which the pseudospheric surface was generated via rotation about the axis) to the axis then decreases correspondingly. The value $|rr'|$ remains everywhere equal to the radius R squared, the radius of the pseudosphere's circumferential circle, which also is coincident with the minimal internal circle of the catenoid. For the toroid, the internal body radius is everywhere constant, equal to r. The external radii of curvature are infinite at the top and bottom surface of the toroid. For any elevation angle theta (θ) for the internal radius r, the inner "external" radius r' becomes R_o/cosine θ, R_o being the central radius of the toroid's internal circle. Accompanying this replete geometry is a curvature map having both the central and the circular singularity; see Fig. 1 for a depiction of these features.

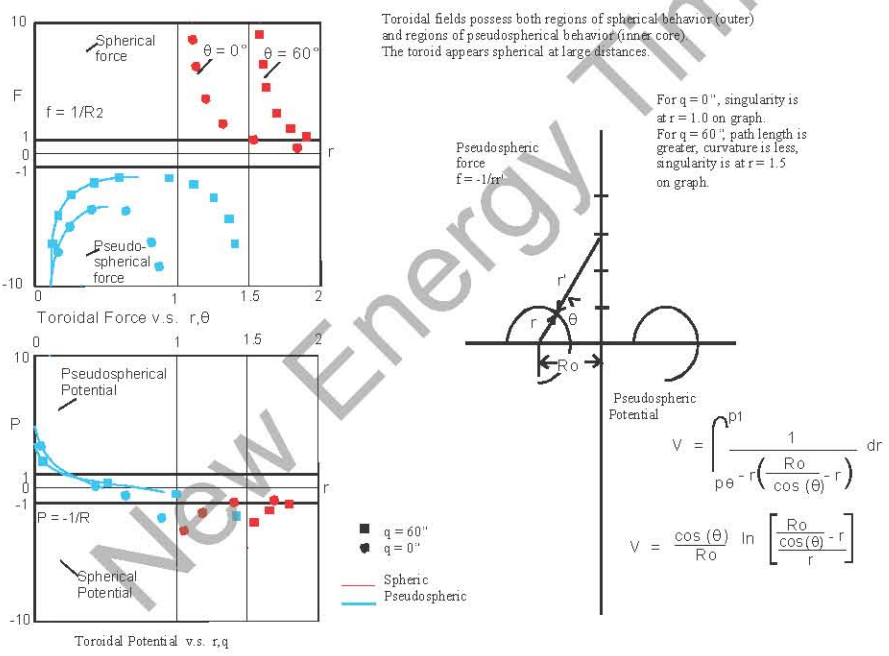


Fig. 1 Comparison of Spherical, Pseudospherical and Toroidal curvature

Integrating the force field to obtain the potential, V

With a toroid, the radius of curvature of the inner portion is a function of the elevation angle θ, and is given as the value $P = -rr' = -r[(R_o/\text{cosine } \theta) - r]$, obtained through examining the work done on a test particle moving on a path inclined by the angle θ from the plane of the toroid's inner circular singularity, starting from a point as close as

possible (ρ_0) to the circular singularity and moving outward as though stationed on the exposed surface of the expanding torus to (ρ_1). From this exercise an interesting feature of the toroidal geometry emerges naturally:

As the torus expands from the ring singularity, its inner radius of curvature, r′ (which is on the opposite side of the surface from the internal body radius of curvature, r) approaches zero in magnitude, depicting an infinite negative curvature for the inner surface at the central axis point, just as the torus has expanded to **close off** the hole. In other words, probing the general expansion of the geometry of the torus has shown that it can support the generation of a central point singularity as is found with the sphere. In this way, the torus can be substituted for the microcosmic innards of the spherical point singularity. The torus possesses both spheric and pseudospheric geometries in one body!

Ordinarily, though, for a partially expanded torus, as one examines the toroid via scanning θ through a full circle, as θ increases the r′ radius of curvature lengthens continuously until θ reaches 90 degrees. While at that moment r′ is infinite, r is yet the same as it was when θ was zero (so r is thus yet finite); so it is then the case that 1/rr′ is zero (1/infinity), indicating that for the top and bottom surfaces of the toroid there is no Gaussian curvature, and they are thus force-free. While this at first may seem a bit strange, what with the ring line that sources the field being directly adjacent to (above or below) those surfaces, one should remember that the ring is seen as sourced via the central spherical singularity discussed in the previous paragraph. As θ is increased from zero to 90 degrees, the pseudospheric (negatively curved) surface of the toroidal potential is examined, with the r′ radius increasing, out to + infinity.

As the θ angle goes beyond 90 degrees, the spheric (positively curved) surface is examined, with the r′ radius now emerging below from - infinity, but on the same side of the surface as the r radius is located. The positive curvature, initially zero, increases to a maximum at the equator of the torus (where theta is 180 degrees) and the other end of the r′ radius has moved in to the position of the central singularity.

The opportunity presents itself to assign the polarity of the rr′ product to the polarity of the cosine of θ, and while this is in the beginning arbitrary, it would serve to keep track of the curvature polarity if θ were measured from the equator clockwise since it is the case that the cosine of zero degrees is positive unity, while the cosine of 180 degrees is negative unity. That would place the 180 degree position on the inner circumference of the toroid, where the curvature is indeed negative, but does make the drawing shown as a part of Fig. 1 a bit less intuitive in the beginning.

As θ changes from the outer equatorial to the bottom surface, the radius of curvature r′ again lengthens, with the opposite end of the radius line moving from the central singularity out to + infinity. As this position is reached and θ goes beyond 270 degrees, the r′ radius returns from the - infinity position, and is again on the outside of the toroidal surface. In the change of θ from 270 degrees to 360 degrees, the far end of the r′ radius moves in from the - infinity position until it is located once again at the starting position for θ equal zero degrees, which happens to be the central singularity position.

Geometric properties of the Sphere, Pseudosphere and the Toroid

The sphere and pseudosphere have equal surface area, $A_{sp} = 4\pi R^2$. The torus has somewhat less surface area than a sphere of radius R_o (which we had assigned as the distance from the central singularity to the center of the internal ring line at the middle of a cross-section of the toroid). However, the surface area of a toroid does become equal to that of a sphere or a pseudosphere just as the torus expands to close the central hole, computed here as $A_t = 4\ \pi R_o r$.

For the pseudosphere, the potential is opposite in sign to that of the sphere; its value is 1/R rather than the sphere's -1/R value. The torus has a sphere-like potential for its outer part due to the positive curvature of the outer portion. For the inner portion of the torus, the negative curvature produces a pseudosphere-like potential. This potential can be described as a function of the radius r and the elevation angle θ. This is done as though one could evaluate a sequence of layered toroids, just as was done for the spherical and the pseudospherical potentials in Hecht's paper. The toroidal potential is thus found to be:

$$V_t = \ln[(R_o/\cos\theta - r)/r](\cos\theta/R_o)$$

Examination of the graphs in Fig. 1 reveals this expression to be differentiable over regions $0 < R < R_o$ and $R_o < R <$ infinity, the differentiated function matching the accompanying force function exactly. Thus the depicted toroidal potential function follows the rule Hecht used for the sphere and pseudosphere, namely, $F = dV/dr$.

To review the steps involved in integrating the function $1/rr'$ and evaluating the limits of the integral shown in Fig. 1, examine the procedure in the Appendix.

Note that evaluation of the function given for V_t over the region $0 < \theta < \pi/2$ gives

$$V_{t-} = \ln[(|R_o/\cos\theta| - \{\rho = |R_o/\cos\theta|\})/\rho](\cos\theta/R_o) = \ln[0/\rho] = -\text{ infinity}$$

same as the pseudosphere, and having a polarization axis as does a pseudosphere.
Also, for $\pi/2 < \theta < \pi$

$$V_{t+} = -\ln[(-|R_o/\cos\theta| + \{\rho = |R_o/\cos\theta|\})/\rho](\cos\theta/R_o) = -\ln[0/\rho] = +\text{ infinity}$$

same as the sphere, and having a uniform equatorial perimeter as does a sphere.

The existence of canceling singularities within the same geometrical body effectively describes the body as a neutral tensile envelope for any situation in which its surface encloses a uniform distribution of force-producing strings or sheets. In other words, the toroid is a balanced container, effectively a superposition of the spherical and pseudospherical potentials. As such, beyond the spherical singularity the toroid has no external expression of its own shape. Only close-scale objects can experience the repulsion field at the center, as expressed (that is, not screened by the ring line potential) in the direction of the polarization axis. **This could be compared to the gravitational field expression of a relativistically rotating black hole, which has the separation of incoming angular momentum flux transformed toward being directed outward along the spin axis in the form of relativistic cosmic jets.** By filling the toroid with sinusoidally wound modal strings, any desired Schrodinger-like wave pattern can be created and maintained in an endless closed space-time loop. For that matter, not only can Russell's pseudosphere-string structures be placed so as to conform to toroidal structure, but also the toroid can form an envelope for the Meusnier Transform helicoids enclosed in that fashion (as hyperbolic stationary waves), this being depicted as the Kovac Transform for the toroid.

PART II: TOROIDAL ENERGY-MASS TRANSFORMATION

Hecht states that the pseudospheric potential function of the nucleus can, by a transformation which "leaves the curvature of the potential surface unchanged" become the electromagnetic wave of zero rest mass. The Meusnier helicoid-catenoid transformation allows that this is possible, but gives no description for the placement of the catenoid within a model of the atom. Wells provides that the energy to mass transformation produces a **string** with a closed period of oscillation along the inner surface of the toroid. In order that this string be retained as a minimal structure, Wells allows that it traverses both the pseudospherical and the spherical surfaces of the toroid in a closed harmonic fashion. Kovac notes that a toroidal object can be likewise transformed from a nuclear domain to a propagated domain rather like the Meusnier Transform, but provides that an uncoiling time is involved as well. If so, then it is possible that we may compare for the **Kovac Transform**, the **Kovac Time** and the **Kovac Distance** with the Planck Time and the Planck Distance, relating those quantities to Meusnier's **wavelength** and Hecht's **catenoid-helicoid size** (which Hecht depicts as equivalent to "a sort of Archimedean screw pump of very small dimensions").

First off, all of the criteria developed by Meusnier are applicable to the Kovac Transform; that is, we visualize the Kovac Transform as an **envelope** for the Meusnier Transform. Therefore, we can say, as $\lambda = 2\pi R$ for the pseudospherical representation, the Kovac Transform uses $\lambda = 2\pi R_o$. And it is also the case that the stationary wave within the toroid is of the hyperbolic form:

$$y = R_o(\cosh(x/R)) = (R_o/2)(e^{x/R_o} + e^{-x/R_o})$$

with the same Klein-Gordon wave relationship. However, it must be realized that we now know that the x and y dimensions can be curled up, forming against the inside walls of the torus like a poster inside a mailing tube. Either x or y may, with adequate curling, become as large as they need to become, since they will have the capability to expand as circular modes inside the torus. As for the potential, the former $V = k \times 1/R$ goes to $V_t = K \times 1/R_o$,

$R_o = \lambda/2\pi$, hence likewise, $V_t = 2\pi K/\lambda$ with K as before, a proportionality constant. For an electromagnetic wave, λ times ν equals the velocity of light, c, so we have $V_t = 2\pi\nu K/c$ like Hecht. Now we have to commit to the notion that all of the energy of the electromagnetic wave is derived from the spherical and/or pseudospherical potentials of the helical string in the toroid, that is, V_p or $V_s = E$. Since by Planck's relationship, $E = h\nu = V_p$ or $V_s = 2\pi\nu K/c$ we can say $K = hc/2\pi$ like Hecht, or we can use the quantum-mechanical $\hbar$ 2 π normalized Planck's constant, like Kovac: $K = \hbar c$.

By generating these expressions we have assigned a relationship between energy (which we can measure) and toroidal potential geometry (or as it is, between spherical and pseudospherical geometry, if you please) that we can perhaps evaluate via nuclear spectroscopy or atomic collisional scattering tests. In particular, note that

$2\pi e^2/\alpha c$ =	$2\pi k/c$ =	h Planck's constant
Sommerfeld's α	Hecht's k	for radiated energy

which can be solved for k in terms of Planck's constant or placed in a ratio which we could then say allows our geometry to relate to Sommerfeld's fine structure constant, that is, the constants of Planck and Sommerfeld contain one another, each being resident at opposite ends of the Meusnier/Kovac Transforms! It is a trivial matter to now finish Hecht's further derivation for the ratio of the pseudospherical force to the force between two electrons, offered instead as the ratio of the combination of the spherical and pseudospherical forces for the toroid to the force between two electrons, needing only the substitution of V_t and R_o for V and R in his expressions as required, i.e.:

$$F = \frac{e^2}{r^2}, \quad \frac{F_n}{F_t} = \frac{e^2/r^2}{-hc/2\pi R_o^2} = \frac{-2\pi e^2}{2hc} \times \frac{R_o}{r^2}$$

and using Hecht's words, (keeping in mind that r and R_o are not necessarily equal):

Since $$\frac{2\pi e^2}{hc} = \alpha$$

the Sommerfeld fine structure constant, we have:

$$\frac{F_n}{F_t} = -\alpha\left(\frac{R_o^2}{r^2}\right) \text{ so } \frac{V_n}{V_t} = \alpha\left(\frac{R_o}{r}\right); \quad \alpha = \frac{r V_n}{R_o V_t}.$$

Thus we see that the same constant that Sommerfeld derived by consideration of the relativistic motion of the electron as well expresses the relationship between spherical and toroidal potentials.

But now we can go one step further, since we suspect that V_n = our V_s, the spherical part of V_t, with $V_t = V_s + V_p$, from Hecht's relationship for α

$$\frac{V_n}{V_p} = \alpha\left(\frac{R}{r}\right); \quad \alpha = \frac{r V_n}{R V_p}$$

$$R V_p = R_o V_t, \text{ and then } R V_p = R_o (V_s + V_p) \text{ or } R = R_o (V_s/V_p + 1)$$

and thus $R_o = (R V_p)/(V_s + V_p)$, meaning that when an atom has radiated all of its thermal energy (which of course is the energy that keeps the electron from going into the nucleus, collapsing to a closed-hole toroid) then ($V_s = 0$) so R_o = R and only the pseudospherical (circular wave) energy remains, it is delivered to the state described by Kovac in his paper [2] containing the section referencing the work of CU researchers Weiman and Cornell [3], a wave of the Bose-Einstein statistical form, organized by superpositional stimulation at a very low energy.

As V_s and V_p are co-resident in the toroid, they must be tensile, that is, they are tied together so as to not allow the energy to bleed away, but also so as not to annihilate one another. For instance, have you ever wondered how an electron could be depicted as orbiting around the nucleus at relativistic speed and yet not lose its proverbial shirt in

synchrotron radiation? As Hecht speculates, perhaps it isn't orbiting but rather (as Hecht says) it is distributed **over the surface of a catenoid** (as a stationary hyperbolic wave). But Wells prefers to show this as a helical sinusoid plastered against the wall of a torus.

Kovac notes [4] that time is involved. Nobody mentioned magnetic field energy (though it appears in Kovac's Fig. 33 in the radiative parts of his diagram, if one chooses to write **electric** and **magnetic** by the pairs of sine waves (one filled in and shaded, the other shown as an envelope). Although often depicted in this self-same fashion in plain wave diagrams, the sourcing of electrodynamic and magnetodynamic energy is fundamentally different. i.e.:

Physical (i.e. gravitational) force systems and/or electromagnetic field systems may be thought of as being Lamellar or Solonoidal as follows:

♦ Lamellar vector point functions -
- · Velocity of a fluid free from vortical motion
- · Gravitational field intensity due to presence of gravitational matter
- · Electric field intensity due to the presence of electric charges
- · Magnetic field intensity in a region containing no moving charges

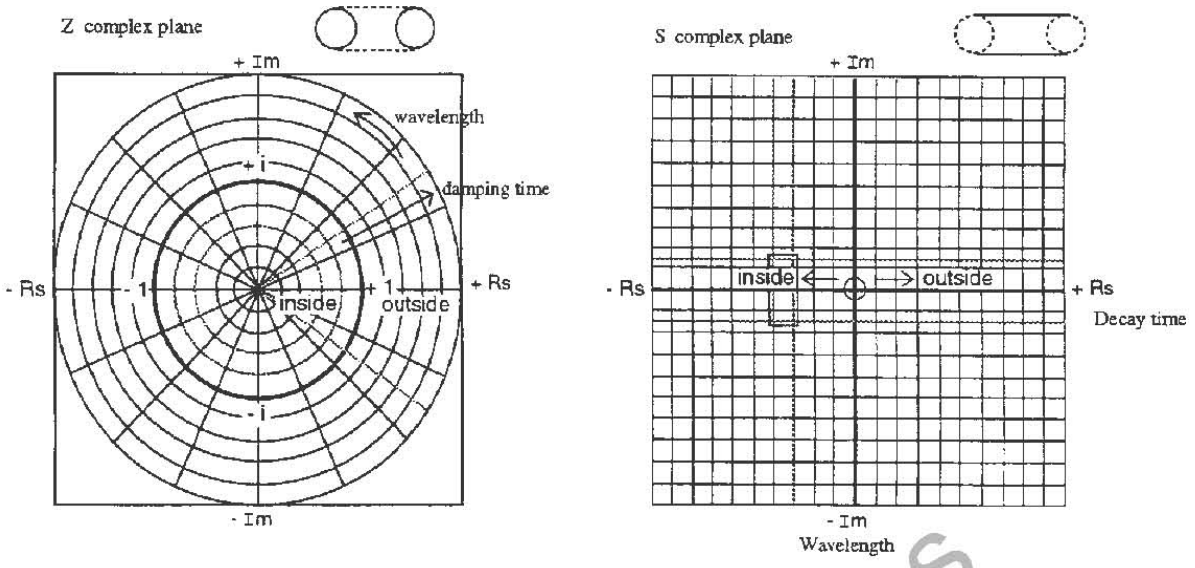
♦ Solonoidal vector point functions -
- · Vortical velocity of an incompressible fluid
- · Gravitational field intensity in a region containing no gravitational matter
- · Electric field intensity in a region containing no electric charges
- · Magnetic field intensity in a region containing moving electric charges

The containment of magnetic energy seems contrary to most other forms.

The existence of a Wells-like potential fibre bundle (as a remotely observed property of a particle or arrangement of particles, such as an atom) is likely. For example, if one sets a computer about the task of preparing graphical images of the Mandlebrot set, the results will usually show broad regions of smoothly varying contours, coupled to other regions having astounding detail, those regions in turn coupled closely to regions displaying seemingly random chaos. However, increasing the magnification of the set generator will generally show that considerable detail and order is found in those regions formerly displayed as chaotic. This comes about because the low magnification and quantization formerly used was undersampling the underlying order and aliasing it as chaos. Higher magnification resolved the apparently chaotic regions into adequately sampled order and coherent detail. Thus it is readily possible that particle scattering tests do, in fact, undersample the underlying order in the fibre bundles in atomic toroids, producing the random chaos predicted via the statistical techniques of quantum probability calculations, as typically applied to electron position and momentum. As Kovac notes [5], time is involved, and this paper points out that the relative scale of the test particle and atomic structure is involved!

Hecht points out [6] that the catenary is the plane projection of the catenoid, and the sinusoidal wave is the plane projection of the helicoid. The plane projection of the unwound radiative toroid is two parallel lines, and the plane projection of the toroid itself is a set of concentric circles, and the plane projection of some views of the toroid are circles connected with parallel lines. In this aspect it is interesting to note that the LaPlace transform of a discretely sampled function may be mapped into the **z** complex plane, upon which a set of concentric circles representing existence or damping times and radial lines representing constant frequency or wavelength may itself be transformed to the **s** complex plane in which the former concentric circles are transformed to parallel lines in the imaginary direction, while the former radial lines are transformed to parallel lines in the real direction (see Fig. 2).

The suggestion is that the transformation from sampled quantum toroidal structure to linear (plane wave) structure may be done by realizing that some physical variables thought to be real-behavior variables are actually imaginary-behavior variables (time, for instance, may be an imaginary variable, transformable in the way the damping



Features of the Kovac transform -- Toroidal mode to Propagation mode
Transform: $F(s) = \ln(F(z))$
Projection -- Concentric circles to Parallel lines

Complex z plane, showing contours of constant frequency or wavelength (radial lines) and constant damping [or half-life] (circles)

Complex s plane, showing contours of constant frequency or wavelength (horizontal lines) and constant damping [half-life] (verticle lines)

Fig. 2 Complex Space-time modes for Kovac Transformation

time circles of the previous paragraph were transformable). It may be that the quantum quantization is only an effect related to difference in scale size. Gravity may be a mitigating force system, since relativistic effects are found for both velocity (large scale) and singularities (small scale) such as black holes which, in spite of the enormous accompanying event horizons are actually small scale compared to the distance between stars and galaxies, which takes quite a while to negotiate even at the velocity of light. Thus evident is the reason the large scale is associated with the velocity of light.

Furthermore, a system of complex vector algebra is supported in Hamilton's quaternion vector algebra [7] and in Penrose's Spinor and Twistor theory [8]. The quantum size is set by the energy levels, and as Kovac points out, the temperature is an important additional factor. The resolution of magnetic dipole moment, for example, is related to quantization by energy and temperature (i.e. Potts spin states [9]). And, of course, particles described in toroidal geometry having internal **vibrating** strings or fibre bundles having harmonic helical structure can conform to requirements of the wave/particle duality. The questions concerning the relationship of $V_p + V_s$ remain for further work. In the accompanying Julia set plot depicting the magnetic spin states, the laboratory knowledge is what makes up one thin line through the figure (the oscillations in state experienced while probing along merely the real axis of the figure). The nature of the information in the entire remaining figure in the complex plane is not as yet physically realized.

Fig. 3 - Mandel/Julia Depiction of a Magnetic Renormalization Function

The figure (part 3) shows the mandel set parametric depiction for a magnetic lattice with temperature approaching the Curie point. (Atr: Pierre Curie). The figure (part 1) shows the Julia set generated at each of three points in the mandel set; a), located at x = 1.185000 (the absolute zero temperature point is at x = 1.000000) is the last elevated temperature before chaos sets in, and shows no grain in the Potts spin state b) is just after loss of the global magnetization communication quality where alternating Potts spin states are evidently sequencing through with rising temperature, and c) is in a region of very high temperature where communication over semi-global scale seems to have re-acquired a new quality of correlation (at x = $\pi/2$). The regularly alternating Potts spin state in the region in the small rectangle is shown in the figure enlarged (part 2).

At the Curie point, the system loses global through local smoothness in the Potts spin states (located along the horizontal (real) axis). While the onset is sudden, it is not without detectable warning. Also, note that communication of the magnetization property is a function of scale, but with the curious condition that the "scale" is more sensitively described as a function of energy or temperature, than it is of a distance/distance metric.

The renormalization function given is from the reference [1], and is for a polynomial of degree 4^{n-1} in the variable x = $e^{J/KbT}$. Positive integral spin-state energy is J, Kb is Boltzmann's constant, and T is absolute temperature.

References for Fig. 3.

1. H.O. Peitgen, P.H. Richter, The Beauty of Fractals, Springer Verlag Berlin/Heidelberg/New York/Tokyo 1986.
2. Elie Cartan, The Theory of Spinors, 1966, Hermann/Paris (& Dover).
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2, 3. Ron Kovac's submission for the Keynote, Friday afternoon, April 26, 1996 session New Energy Symposium (Denver, CO) "Support From Other Recent Work," "Freezing Rubidium Atom Turns into Electromagnetic Wave: Bose / Einstein Condensate" and the reference {9} C. Wieman, E. Cornell, Univ. of Colorado, Boulder; *Colorado Daily*, July 14-16, 1995, vol 103, no 117.

Any Quantum Mechanics textbook will discuss the statistical differences for half integral versus integral spin states with respect to the Pauli exclusion principle and amplification via stimulation. For example, see Roll G. Winter, Quantum Physics, Wadsworth Publishing Company, Belmont California, pp 180-185. Or see French and Taylor, An Introduction to Quantum Physics, (M.I.T. Introductory Physics Series) W.W. Norton and Company, section 13-5, pp 566-569.

4, 5. Ron Kovac's New Energy Symposium (1996) submission for the Keynote, concerning "Phi," page 14. In this reference, the time elapsed in receiving or transmitting electromagnetic energy is related to the reciprocal of the natural frequency of the toroid, and is $f_{h'}$ for a single toroidal excitation, or $f_{h''}$ for a sum of sequential exchanges involving a sequence of toroidal states.

6. Ron Hecht, "Potential in a Space of Negative Curvature." *Research Communications*, Winter 1992, pp 14-22, on pseudospheric potentials and the research of Gauss and Beltrami, provides the background for the work that was in this article extended to the toroid, and is a required reference with respect to comparatively understanding the development. The reference cited here concerning the projection profile of the parts of the Meusnier transform is

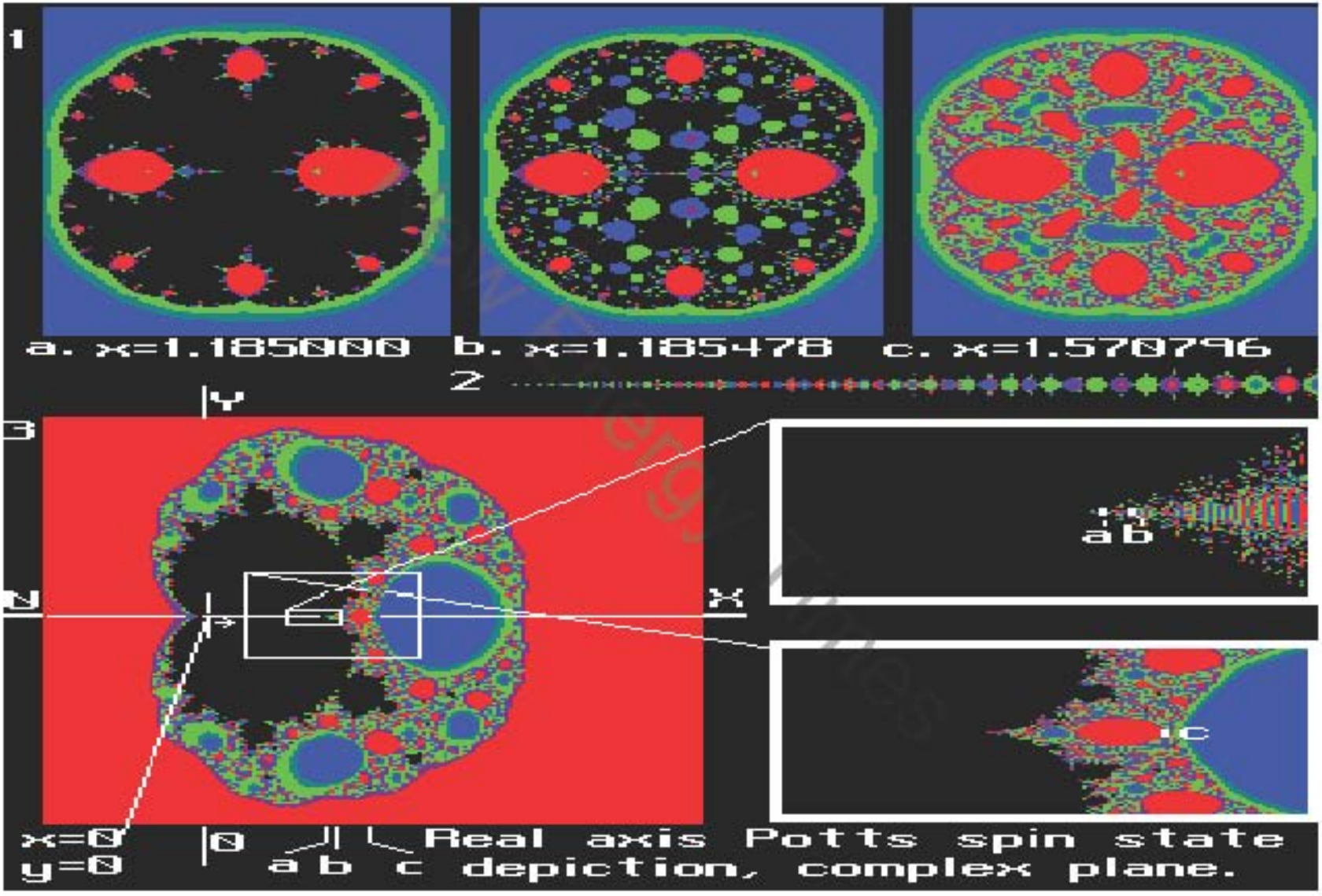

Fig. 3. Mandel/Julia Depiction of a Magnetic Renormalization Function

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on p 18, right-most column. Included is mention of the "cutoff frequency" where the wave changes from sinusoidal form to exponential form. In the text and equations of section 22.5 of Gravitation (Misner, Thorne, and Wheeler, published by W.H. Freeman and Company, San Francisco, 1973), on p 572 the exponential expression for a circularly polarized beam is discussed just below equation 22.5 dealing with geometric optics in space-time. The form is EXP(i(ω(z-t))), while Hecht's wave is of the form EXP(k(z)). In Edward C. Jordan, Reference Data for Engineers, (Howard W. Sams & Company, Indianapolis, Indiana) in section 30-3,4, cutoff frequency is discussed with respect to rectangular and circular wave-guides using the form EXP(i(ω)t - $(\gamma)_m$, n^z) with gamma describing the various propagation modes determined by the dimensions of the wave-guide. It is explained that m and n are integers and that if gamma is imaginary, then it produces a phase change versus distance in the same fashion that omega produces a phase change versus time. However, if gamma is real, then the wave is attenuated versus distance exponentially, and that is depicted as the cutoff condition. The conductive boundaries of the "wave-guide" then must be provided by mobile charges in atomic structure and a complex space-time descriptor must be used to depict this. The reference cited by the authors listed above for the wave equations is (note spelling of the name): M. Kline, "Asymptotic Solution of Linear Hyperbolic Partial Differential Equations," *J. Rat. Mech. & Anal.*, vol 3, 1954, pp 315-342.

Note that a Kovac transform from nuclear space (stationary mode) to macro space (propagation mode) is the Complex Natural Logarithm of the nuclear space expressed in complex space-time, phased according to whether the transform was direct (imaginary time converted to real time) or tunneled (imaginary time converted to real spatial separation) and "sampled" or quantized via the Planck UCV (unit compact vector).

7, 8. Elie Cartan, The Theory of Spinors, Hermann/Paris (& Dover); and S.A. Hugget & K.P. Tod, An Introduction to Twistor Theory, London Mathematical Soc. Math. Texts, Cambridge Univ. Press, 1985. A full discussion of the basis of Hamilton's Quaternion vector algebra is found in the two references cited in the New Energy Symposium pre-release. Historical notes and some descriptive text is provided in Peter V. O'Neil, Advanced Engineering Mathematics, Wadsworth Publishing Company, Belmont, California, p 569, and with some expressions and figures, pp 1006-1008. With respect to this reference and Maxwell's involvement in the separation of vectors and scalars for computational purposes (as occurs naturally in the quaternion form), for this work, directed toward application in the Kovac transform, I personally would describe a scalar as "a vector in the time direction." An additional reference with applications is the entire Chapter 41 of Gravitation, by Misner, Thorne, and Wheeler (W. H. Freeman and Company, San Francisco, 1973) which is entitled "Spinors" and has a section on the correspondence of vectors and spinors (section 41.6, pp 1150-1151).

9. The reference for Potts spin states was included in the text submitted for the New Energy Symposium pre-release. See H.O. Peitgen & P.H. Richter, The Beauty of Fractals (Springer Verlag, 1986) in that section. Their citations are B.L. Derrida, L. De Seze, C. Itzykson, "Fractal Structure of Zeros in Hierarchical Models," *J. Statistical Physics*, vol 33, 1983, pp 559-569, and probably L. Onsager, "Crystal Statistics I. Two-Dimensional Model with an Order-Disorder Transition," *Phys. Rev.*, vol 65, pp 117-149. For the physics, see any fundamental text on solid state physics, i.e., Ashcroft/Mermin, Solid State Physics, published by Holt Rinehart Winston 1976, Chapter 33, "Magnetic Ordering," or C. Kittel, Introduction to Solid State Physics, John Wiley and Sons, Chap. 14 & 15, "Dia/Para Magnetism & Ferromagnetism."

[*] Wells' papers in the IEEE Transactions on Plasma Science, vol 17, no 2, April 1989, and vol 18, no 1, February 1990, describe "quantization of the solar system" in terms of Titus-Bode and alignment with the J0 and J1 Bessel functions. Use a complex space-time J0 and J1 to extend that to the interior of the toroid; note that many optical phenomenon do show amplitude/phase modulation for iso-mass-energy mode exchanges or frequency modulation for energy exchange with coupled systems. These modulation modes are of course described via the Bessel functions; see the reference Jordan Edward C., Reference Data for Engineers, Howard W. Sams and Company, section 23, pp 7,8 describing this. If the radiated electromagnetic wave is governed by this, the Kovac/Meusnier transforms can be used to project it back to the nuclear source. The only limitation to the reconstruction on the nuclear side is that the interior of the toroid is governed by the z-transform, which is a Planck UCV (unit compact vector) **sampled** (discretized) function when viewed at the large scale of wave propagation in real space via the s-transform, and is thus **uncertain**.

RIFT ZONES AS AN INEXHAUSTIBLE SOURCE OF HYDROGEN ON EARTH (NEW PERSPECTIVES OF ECOLOGICALLY CLEAN ENERGETICS)

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ABSTRACT

A newly identified regularity in the distribution of elements in the Solar System has been used to re-evaluate the primordial composition of Earth; it is argued that it may be possible to discover in rifts zones oxygen-free alloys and compounds at depth accessible to drilling. Pumping water there must release heat and hydrogen. The most promising are the western USA and Canada, East Siberia, Jordan-Dead Sea region, Rein graben, and Middle Ocean Ridges of Earth.

RIFT ZONES AS AN ENERGY SOURCE

The deadlock we have been facing has become apparent lately: on the one hand, further progress requires ever growing energy production while on the other, this option invariably leads to more polluted environment so that life becomes impossible on Earth. Petroleum, gas, coal and uranium are believed by many to exhaust the list of the main sources of energy which underpin future expansion of the scope of energetics. They argue that there is no other real energy alternatives to the Earth's interior fuels. This could be true if we sure of our knowledge of the Earth's entrails and their composition. However, the present concepts of the structure of interior zones (the core is iron, the mantle is silicate, i.e. fully oxidized) have never been proved being in fact only a speculative hypothesis.

We have achieved more certainty in this problem due to the discovery of a previously unknown regularity in the distribution of elements in the Solar System which is contingent (dependent) on their ionization potentials. This empirical dependence has led to the primordial composition of Earth, which in its turn provides better reasons to judge the composition of inner geospheres at the present stage of terrestrial history.

We may argue in particular that the Earth's silicate-oxidized shell can be traced only to a depth of 300-550 km (beneath continents as the depth is even shallower below the oceans). Still deeper, as far as the core, the interior is composed of oxygen-free compounds and alloys dominated by silicon, magnesium and iron (with an approximate ratio of 3:2:1). High pressures experiments have demonstrated full conformity of this hypothesis to the **thin** structure of the mantle established by seismic research.

Our concept suggest that zones of modern rifting should be marked by the oxygen-free substance uplifting towards the surface. Remarkable in this respect are the projections of **anomalous mantle** which underlie all modern rift structures attaining depths of 3540 km. Seismic velocities and densities in these prominences coincide with those of Fe-Mg-Si alloy with the composition determined with our reconstructions. Moreover, in certain cases rift structures may house zones with abnormally high conductivity at a depths of 10-15 km from the surface. It has been traditionally attributed to hypothetic accumulations of sulfites or to grafitization, presence of mineralized waters, or to high temperatures. We believe that the anomalously high conductivity at those depths may be due to depth-derived oxygen-free alloys that penetrate the crust in separate **tongues** that reach out of the anomalous mantle projections. In addition, the **tongue's** anomalous conductivity has a semi-conductor character which ties with the semi-conductivity of the principal phases (Mg-silicides, Fe-silicides and natural silicon) that are dominate in the hypothetical composition of the deep-seated substance.

Deep electromagnetic sounding in Russia has helped detect in the south of the Siberian platform, within the Tunka rift depression a zone of anomalously high conductivity at the depth of 6-8 km. (The Tunka depression is situated in the southern-western part of the Baikal rifting area. It stretches latitudinally to 150 km, and is up to 35 km wide in its middle part.) Our research thus suggests a presence of oxygen-free alloys inside rift structures at depths accessible to state-of-the-art drilling technologies.

These new ideas of the composition of the Earth's interior open new prospects in terms of the terrestrial energy resources since the silicon and magnesium that dominate in the oxygen-free alloys are oxidized in their interaction with water releasing big amounts of hydrogen and heat. So, if it proves possible to pump in water there, where these elements are not oxidized, we can derive energy from there in form of **hot hydrogen**. If burnt, it also releases a lot of heat and exactly the same amount of water as was consumed for oxidation. Thermal efficiency of this source of energy is no worse than the heat-producing capacity of the best grades of coal (per unit of weight) while the consumption of atmospheric oxygen is several times less.

The new source of energy carries a promise of ideally clean ecology since burning hydrogen produces only water. It has been already termed, therefore, "the fuel of the future." However, it is clear that to obtain this clean fuel, we have to consume **dirty** energy in amounts greater than that obtainable from hydrogen burning (due to unavoidable losses in the technological chain). Our option makes its possible to generate hydrogen without any energy spent and, in addition, produce a lot of it. It may be a wonderful outcome for the seemingly insoluble controversy of the ever growing requirements and the necessity to preserve the environment.

Of interest in this connection, apart from the Baikal rifting area, are the rift of the Jordan River and the Dead Sea, the Rein graben, western USA and Canada, rift structures of Eastern Africa, and at last Middle Ocean Ridges of Earth.

Judging by the dimensions of electrically conducting bodies, the scope of crustal penetration by oxygen-free alloys is such as to suggest an inexhaustible source of energy (in term of man's requirements). In the present situation, we've got to know if it is our chance, and know it as soon as possible before the traditional power production practices have brought the planet to ecological disaster. Besides, if the prediction is confirmed, it will take some time to overcome a host of formidable technical problems. This is undoubtedly the case when international co-operation is a must.

Therefore, we propose to all interested, to join their efforts to realize deep drilling on the Tunka depression (or any other identical structure in the world, for example, west of Canada and USA) which may open new vistas for the creation of the ecologically clean and safe (as opposite to nuclear) energetics.

EDITOR'S NOTE: For the reader who may want to explore Larin's work in more detail, see Larin's book, Hydridic Earth, the New Geology of our Primordially-Rich Planet, c 1993, Polar Publ., P.O. Box 4220, Station C, Calgary, Alberta 2T2 5N1 Canada.

EDITOR'S CHOICE PAPERS

HYDROGEN GAS FROM VACUUM
Part I

Paul E. Rowe[1]

ABSTRACT

When explosives containing aluminum powder were detonated in vacuum, much more gas was produced than was expected on a theoretical basis. A literature search revealed that other experimenters (some well known and highly respected) had produced surprising quantities of hydrogen gas in and apparently from vacuum. Further experimentation revealed that the extra gas produced from explosions was also hydrogen.

The formation of hydrogen gas from vacuum requires energy. Similarly conversion of hydrogen into vacuum may produce energy without violating the laws of thermodynamics.

Is it a working hypothesis that vacuum is not a void but rather a matrix of protons and electrons?

HYDROGEN FROM VACUUM

In 1959, I detonated explosives containing aluminum powder in vacuum. The amount of gas produced was about 150% of the maximum theoretical value. I was unable to find conditions which produced less gas. In 1980, I performed a literature search to determine whether other experimenters had reported similar results.

The experiments most similar to mine were reported by Gerald L. Wendt and Clarence E. Irion [1] of the University of Chicago. They atomized tungsten wires in a carbon dioxide atmosphere using high voltage capacitor discharge. This caused fine, molten tungsten particles to be dispersed through carbon dioxide, much as my experiments had dispersed fine, molten aluminum particles through gases produced by the detonation. After the discharge, they dissolved the carbon dioxide and were surprised to find that some gas remained. They did not determine the nature of the gas but did show that it was not any of the expected decomposition products of carbon dioxide. They performed 21 experiments and obtained this gas in each experiment. The quantity of gas varied widely from experiment to experiment. The following quote is from their paper:

> *"The gas evolution is very irregular, but this is probably due to irregular conditions of explosion; it is impossible with the present technique to produce explosions of uniform brilliancy and temperature. The volume of gas produced is so large as to exclude its arising from gas dissolved by the wire, for the average volume of the wires was 0.0381 cubic millimeter, and the average volume of the gas was 26,500 times greater."*

In the early part of this century, hydrogen gas was often introduced into a vacuum by heating fine platinum or palladium tubes attached to the system. The following quote is from a 1903 paper of Harold A. Wilson [2], a highly respected British experimenter:

> *"In the experiments in hydrogen at low pressure the hydrogen was obtained sufficiently pure by allowing it to diffuse through platinum. A spiral of fine platinum tubing, 0.5 millim. external and 0.25 millim. internal diameter, was sealed on the apparatus at one end and the other end fused up. On heating this spiral in the flame of a spirit lamp, the hydrogen present in the flame diffused through into the apparatus. In this way the pressure could be increased several tenths of a millimeter in one minute when the total capacity of the apparatus was about 300 cub. centims.*

[1] Address: 71 West Way, Mashpee, Massachusetts 02649

The spectrum of a discharge in hydrogen let in this way was examined, and appeared to consist almost entirely of the hydrogen lines. It was thought that faint traces of the CO spectrum could sometimes be seen, but it was not certain that any CO entered through the platinum spiral."

It was known that hydrogen was absorbed by platinum; so Wilson assumed that hydrogen was produced in the flame, absorbed by the outer surface of the platinum tube and released by the inner surface of the tube. Where else could it have come from?

It seemed to me, however, that Wilson's experiment bears a certain resemblance to my experiment and to Wendt's experiment. In each case, a hot metal surface was present and gas was produced. Could the gas, in all cases, have been hydrogen? Neither Wendt nor I had any reason to check the gas we had produced for hydrogen. I performed experiments where the wire was heated electrically. Considerable hydrogen was produced indicating that it did not come from the flame.

After no longer having access to explosives, I set up an experiment where a mixture of fine, chemically pure aluminum and cupric oxide powders were ignited in partial vacuum using an electrically heated resistance wire. The expected products were aluminum oxide, copper and lots of heat. One would expect no gas other than a little oxygen, which might have been released from heated copper oxide and not reacted with the aluminum, and perhaps a little gas which had been absorbed by the walls of the detonation chamber, prior to the experiment. When current was passed through the resistance wire a loud ping was noted and the detonation chamber became quite hot. When the chamber cooled, the pressure had increased from about 0.1 percent of an atmosphere to about 20 percent of an atmosphere.

The gas obtained was almost half that which would have been obtained if all the oxygen in the cupric oxide had been released as oxygen gas. If this had happened, the system would have absorbed energy, not given it off. Many such experiments were performed and, in each case, considerable gas was produced.

Experiments were performed where a second resistance wire, was placed, away from the powder mixture, in the detonation chamber. The coil was heated, as above, and the system was allowed to cool. Only very minor pressure changes were noted. An excess of air (assuming the gas originally produced to be hydrogen) was let into the chamber and the second coil was heated electrically. A ping was noted and the chamber became quite warm. When the chamber cooled, the pressure was quite close to that calculated assuming the original gas had been hydrogen, which reacted with the oxygen present in the air to produce water and that some of the water had liquified leaving the water vapor pressure expected at ambient temperature.

A similar experiment, using much less of the mixture, was performed in a Pyrex flask. The gas produced was colorless. Air was let into the flask and the wire was heated. A loud ping and a bright flash resulted. The gas which remained was colorless and odorless. I have no doubt that the gas produced from the original detonation was hydrogen.

The most likely source of hydrogen was water absorbed in the chamber walls and/or the explosive mixture. Prolonged heating of the chamber, containing the explosive mixture, while it was being evacuated would be expected to greatly reduce absorbed moisture. This proceedure did not affect the quantity of hydrogen produced.

In a 1905 paper, Clarence Skinner [3] of the University of Nebraska reported the surprising appearance of hydrogen gas during the passage of electricity through a discharge tube containing low pressure helium. His experiments differed from those described above. Two electrodes were inside a partially evacuated glass tube and the voltage across the electrodes was increased until a DC electrical current passed through the tube. He wrote:

" .... it was observed that no matter how carefully the gas was purified the hydrogen radiation, tested spectroscopically, persistently appeared in the cathode glow. Simultaneous with this appearance there was also a continuous increase in the gas pressure with the time of discharge."

Skinner then gave strong evidence that the hydrogen was produced at the cathode; just as it is produced at the cathode in the electrolysis of water. He pointed out that the initial rate of hydrogen production was that predicted by Faraday's law of electrolysis. The quantity of hydrogen produced at a small silver cathode was particularly surprising:

"With a freshly polished metal as cathode the gas pressure increases at first at a constant rate, but after a time this rate begins to drop off until the pressure appears to have reached a constant maximum value. Silver was depleted in this way giving off about two tenths of a cubic centimeter (measured at atmospheric pressure) of hydrogen. The current was then broken and the hydrogen absorbed by the Na, K cathode. After standing in helium over night and then tested again the next morning, it was found to have a new supply equal to the one given up the day before. Without allowing it any chance of regaining hydrogen from an external source it was thus depleted six or eight times during the course of two weeks and found to give off at each time about the same amount of gas. With a few hours rest only a slight recovery was noticed."

"After this series the silver was removed from the tube, repolished, and then tested again with the same results. Altogether about two cubic centimeters of gas had been given off by this silver disk, which is 15 millimeters in diameter and about one millimeter thick. It shows no sign of having its supply of hydrogen reduced in the least."

The volume of Skinner's silver cathode was about 0.177 cc. He obtained 11.2 times this volume (at standard temperature and pressure) of hydrogen. In 1928, E.W.R. Stearcie and F.M.G. Johnson [4] of McGill University reported on an exhaustive study of the solubility of hydrogen in silver. They found the solubility increased with temperature and with the pressure of hydrogen. At 400 degrees Centigrade and a hydrogen pressure of slightly over one atmosphere, silver absorbed 0.007 volumes (at standard temperature and pressure) of hydrogen. Skinner obtained 1600 times as much hydrogen from his cathode which, *"shows no sign of having its supply of hydrogen reduced in the least."* Almost certainly, the hydrogen which Skinner produced did not come from the silver, which had been stored in air and then under vacuum, at room temperature.

Skinner noted that his cathodes became tarnished during discharge and that cathodes which remained tarnished on standing did not *"recover their supply of hydrogen."* Metals, like silver, whose tarnish *"dusted off"* on standing did recover their supply. If highly reactive atomic hydrogen were produced at the cathode, it would be expected to react with the surface of the cathode to form a hydride. If the hydride were stable the surface would retain its hydride coat. Silver forms an unstable hydride which slowly decomposes into silver and hydrogen gas. Overnight, the silver powder which formed might be expected to dust off leaving a fresh silver surface on the cathode.

Skinner performed many different experiments and reported many unexpected results. All of them can be readily explained, **if one assumes that atomic hydrogen is produced at the cathode surface**, two hydrogen atoms combine to form diatomic hydrogen which, in turn, combines with atomic hydrogen to form triatomic hydrogen and that triatomic hydrogen carries the current through the discharge tube at a lower voltage than is required to produce hydrogen from the vacuum.

In 1913, Nobel laureate, Sir J.J. Thomson [5] reported finding a positive ion having an atomic weight of 3 in his discharge tubes. Whenever it was found, hydrogen was also present. He assumed that it was triatomic hydrogen which had lost an electron.

In 1920, G.L. Wendt and R.S. Landaur [6] of the University of Chicago produced triatomic hydrogen in a hydrogen filled discharge tube and determined its properties. They found that it was very reactive and quite unstable. It decomposed into diatomic hydrogen in about a minute. I believe that its properties are compatible with the above explanation of Skinner's results.

In 1914, George Winchester [7] of Washington and Jefferson College reported results of electrical discharge experiments performed at much lower pressures and higher voltages than were employed by Skinner. He gave graphs showing that the pressure increased with time and then leveled off to a very slow linear increase. Using the spectroscope, he determined that the gases produced were hydrogen, helium and neon. The helium and neon ceased to be produced in time. The following quote is from his paper:

"The case of hydrogen is different; I have sparked tubes until the electrodes were entirely wasted away and this gas can be obtained as long as any metal remains."

Winchester's graphs are consistent with a rapid initial production of hydrogen which slows as triatomic hydrogen is formed. This is followed by a steady, very slow pressure increase as triatomic hydrogen is kept at equilibrium concentration by formation at the cathode at the same rate as it decomposing into hydrogen.

In work leading to the development of the mass spectrometer, Sir J.J. Thomson subjected gases to electrical discharge in order to produce positive ions. He accelerated these ions through electrical and magnetic fields and determined their mass by the position at which they struck a photographic plate. He was unable to obtain a plate which the line representing hydrogen was absent. In a 1920 paper [8], he included the following statement:

> *"I would like to direct attention to the analogy between the effect just described and an everyday experience with discharge tubes - I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of positive rays. Though you may heat the glass of the tube to the melting point, may dry the gases by liquid air or cooled charcoal, and free the gases you let into the tube as carefully as you will from hydrogen, you will still get hydrogen lines by the positive-ray method, even when the bulb has been running several hours a day for nearly a year."*

I believe that Thomson's technique for ionizing gases also produced hydrogen from vacuum. As long as he continued his discharge, he kept producing hydrogen.

In 1949, Saul Dushman of the General Electric Company wrote, the book, Scientific Foundations of Vacuum Technique which continues to be considered by many high vacuum experimenters as the authoritative book in its field. In this book, Dushman discussed electrical discharge experiments he performed with Andrews and Huthsteiner [9] In a thoroughly evacuated glass bulb containing only tungsten electrodes and mercury vapor, they produced enough hydrogen such that *" .... if piled on the glass, would form a layer at least 25 molecules deep."*

Hydrogen was produced even when the voltage drop was as low as 50 volts. He noted that hydrogen was not liberated, without discharge, when the glass walls were heated to their softening point. He referred to others who had reported obtaining hydrogen:

> *" .... to some extent in nitrogen, carbon monoxide and argon. In the presence of mercury vapor this phenomenon was extremely marked."*

I believe vacuum was converted into hydrogen at the mercury surface, under Dushman's electrical conditions.

I have performed many other experiments, which I interpret as demonstrating that hydrogen gas is quite readily prepared in and from vacuum. If this is the case, vacuum is not a void.

Results of continuing experiments suggest that energy is absorbed as the hydrogen is produced from vacuum. If vacuum is at a lower energy level than hydrogen, conversion of hydrogen into vacuum would produce energy. No Laws of Thermodynamics would be violated. Such a conversion of hydrogen into vacuum may be involved in the Patterson Power Cell™. [10]

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HYDROGEN GAS FROM VACUUM
Part II

Paul E. Rowe

A BRIEF HISTORY OF THE AETHER

In 1690, Christiaan Huygens published, "Traite de la Lumiere" [1]. This writing included the following observations:

1. In order to have a mechanical explanation for the passage of light, a medium must be present which carries light waves, just as a material must be present to carry sound waves. Sound does not pass through an evacuated chamber because matter has been removed. Light passes readily through an evacuated chamber; so its medium must still be present.

2. When a U-shaped glass tube, sealed at one end and filled with mercury up to the sealed end, is evacuated through the open end, light passes through vacuum which develops between the mercury and the seal. This indicates that the medium must easily pass through the mercury and/or the glass. This, in turn, suggests that the individual particles of the medium must be quite small compared to the distance between the atoms of these materials.

3. Huygens compared the transmission of light to the action which occurs when a hard sphere strikes a line of similar hard spheres. The motion is passed through the individual spheres to the last sphere. The motion is transferred very rapidly but not instantaneously. One at a time, each of the spheres contains all of the energy from the original collision. He suggested that light is transferred similarly and that each energized particle transfers all of its energy to another such particle.

One may picture a device consisting of a line of touching, fairly large, steel ball bearings each suspended by its own string [such an assembly can be purchased at some gift shops]. When an end ball impacts on its neighbor, the ball at the other end seems to immediately bounce off. Of course, the action is not instantaneous, the time required depends on the physical properties of the material from which the balls are made. If one accepts that the particles of Huygens' medium are small enough to fit easily between atoms and also are touching, the concentration of these particles must be very great, indeed. **Most present day scientists will admit that action at a distance [for example, magnetism or gravity] through a void has not been satisfactorily explained.** Huygens' medium of effectively touching particles eliminates this problem. The forces are transferred through the medium. His medium also leads to a simple explanation for the dual [particle and wave] nature of light. At any given instant, the energy formerly present on any particle is present on one and only one other particle. The number of activated particles stays the same as the wave effect travels through the medium. If the wave travels in all directions, the concentration of activated particles decreases with the square of the distance. The energy of light over a given area is known to decrease in this fashion.

If, at a given instant, an activated aether particle is adjacent to an atom, it may transfer its energy to that atom just as a projectile would. An instantaneous snapshot would show the positions of the activated particles but would not show to which particles their energy would be transferred. A time exposure would show the wave effect of the phenomenon. This may remind some physicists of the Heisenberg uncertainty principle.

Huygens suggested that each point of a wave front is a new source of waves. This became known as Huygens' principle. Using this principle he explained the refraction of light.

Huygens' ideas on this subject were revived in the early 19th century to explain optical phenomena which had just been discovered (diffraction patterns, attributed to wave interference). The fact that Huygens' concepts explained phenomena which were not discovered until years after his death was, at the time, considered as confirmation of his concepts.

It is a hypothesis that the vacuum consists or precursors of protons and electrons (as proposed in Part I) and that this matrix conforms well with Huygens' ideas.

In a paper published in 1855 [2], Michael Faraday quoted a letter of Sir Isaac Newton to the effect that, considering the idea that gravity could act at a distance without an intervening agent is absurd. Faraday, himself had an open mind on the subject of the aether. The following quote is from a speech he gave in 1851, while discussing magnetic force [3]:

> *"I am more inclined to the notion that in the transmission of the force there is such an action, external to the magnet, that the effects are merely attraction and repulsion at a distance. Such an action may be a function of the aether; for it is not at all unlikely that, if there be an aether, it should have other uses than simply the conveyance of radiations."*

In 1865, James Clerk Maxwell wrote the following when discussing light [4]:

> *"From the phenomena of heat and light we receive data giving us some reason to believe in the existence of a pervading medium, of small but real density, capable of being set in motion and of transmitting motion from one part to another with great, but not infinite velocity."*

Maxwell was the great physicist who developed Maxwell's equations, which are still employed in calculating the speed of light in various media and the reflectivity at interfaces between media. To make these equations work, he had to assume real values for properties of a vacuum (dielectric constant and magnetic permeability). This author finds it impossible to believe that a void can have such properties. Maxwell wrote the section on the aether for the ninth edition (1875-1889) of the Encyclopedia Britannica. It ended with the following paragraph:

> *"Whatever difficulties we may have in forming a consistent idea of the constitution of the aether, there can be no doubt that the interplanetary and interstellar spaces are not empty, but are occupied by a material substance or body, which is certainly the largest, and probably the most uniform body of which we have any knowledge."*

In a speech given in Philadelphia in 1884, Lord Kelvin (noted scientist who served as the president of the Royal Society) included the following three statements [5]:

> *"You can imagine particles of something, the thing whose motion constitutes light. The thing we call the luminiferous aether. That is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and substantiality of the luminiferous aether."*

> *"An exhibition of red light travelling through space from the remotest star is due to propagation by waves or vibrations, in which each individual particle of the transmitting medium vibrates to and fro 400 million million times a second."*

> *"..... you may regard the existence of the luminiferous aether as a reality of science; that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity - a rigidity so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned with the wavelengths I have mentioned."*

Heinrich Hertz, who discovered radio waves, made the following statement in a 1890 speech [6]:

> *"It is morally certain that the wave theory of light is true, and the conclusions that necessarily follow from it are equally certain. It is therefore certain that all space known to us is not empty but is filled with a substance, the aether, which can be thrown into vibration."*

Up to the twentieth century, the existence of a medium, which carried electromagnetic radiation and very likely gravity was generally accepted as fact by the scientific community. Since the earth was considered not to be the center of the solar system or the universe, it was felt that the earth must be moving through the aether. In 1881,

A.A. Michelson and E.W. Morley began a series of experiments designed to measure the rate of movement of the earth through the aether. They knew the velocity the earth required to keep it in orbit around the sun. If the earth were traveling through the aether even at a reasonable fraction of that velocity, their experiments would have detected it. They detected no such movement. Their negative results were the most important factor in starting a trend in physics which eventually discredited the aether concept.

One reason for the demise of the aether may have been the general tendency of the intelligentsia of the time to demand more abstract concepts. Modern art and modern music had recently become popular. Why not modern physics? During the first decade of this century, a controversy raged between the "**aetherists**" (mostly from England) and the "**antietherists**" (mostly from continental Europe). This might have been expected, since abstract art and modern music also originated on the continent.

In 1909, Sir Oliver Lodge published, The Aether of Space [7]. The book includes the following statements:

> *"Again, take a steel bar itself: when violently stretched, with how great tenacity its parts cling together! Yet its particles are not in absolute contact, they are only virtually attached to each other by means of the universal connecting medium - the aether - a medium that must be competent to transmit the greatest stresses which our knowledge of gravitation and of cohesion shows us to exist."*

In explaining the results of Michelson and Morley's experiments, Lodge stated:

> *"The persistence of terrestrial and planetary motions shows that the aethereal viscosity, if existent, is small; or at least that the amount of energy thus got rid of is a very small fraction of the whole. But there is nothing to show that an appreciable layer of aether may not adhere to the earth and travel with it, even though the force acting on it be but small."*

That is, if the aether in the vicinity of the earth tends to move and spin with the earth, as does everything else at the surface of the earth, the results of the Michelson and Morley experiments are just as would be expected.

In a 1924 book, Atoms and Rays [8], Lodge continued to use the aether concept in explaining physical phenomena:

> *"All the light that we experience can be resolved into vibrations or tremors in the aether. That is how we first knew about the aether. But all electric and magnetic phenomena, and therefore all chemical activity, are likewise known to be modes of manifestation of the Aether of Space, the complete manner and meaning of which have still to be worked out.*
>
> *"So the question arises — What is Matter? Is that too a manifestation of some peculiar properties in the Aether? We know now that matter is built up of protons and electrons. But when we come to analyze these into their fundamentals, we find more than a hint that they are but special modifications in the all-pervading aether, and are essentially resolvable into aetherial energy of a specific kind. Hence we are beginning to think that matter itself is a form of energy."*

This author believes that the above quote comes close to agreeing with the suggestion in part I of this paper, that the aether and matter have the same fundamental components that is, protons and electrons.

In a 1950 interview [9], Albert Einstein said that he wasn't aware of Michelson and Morley's results when he wrote his special theory of relativity but that the results were just as he would have expected. He said he was influenced the most by the observation of stellar aberration and Armand Fizeau's measurements of the speed of light in moving water.

To this author, Fizeau's results appear to corroborate Lodge's conclusion. Fizeau was the first to determine a reasonably accurate value for the speed of light. In 1851, he found that the speed of light in moving water was greater when the light was moving along with the water than when the light was moving in the opposite direction. This would be expected if matter tended to carry aether along with it as suggested by Lodge.

Stellar aberration may also be consistent with Lodge's view.

In order to determine the position of a star an astronomer must first determine the orientation of his telescope when the star is centered and then correct for the effects that he knows affect the starlight as it enters the vicinity of the earth (for example, the bending of light by the atmosphere). After correcting for all the known factors, the star still appears to move in a small ellipse and its position on that ellipse depends on the time of year on earth. No one believes that stars are moving in ellipses which are based on the time of year on earth. There must be a factor for which astronomers have not corrected.

If the aether in the vicinity of the earth tends to move with the earth, it is also moving relative to the aether in free space. For this reason, light should be slightly bent as it moves from free space into the vicinity of the earth. The direction of this bending should be different in March than in September, since the earth is moving in the opposite direction relative to free space.

Aether under the influence of the sun might be expected to move with the sun as it travels through space. If this effect continues beyond the earth, it would contribute the stellar aberration as noted on earth. This effect would also depend on the time of year on earth. I believe the chief reason that Lodge's explanations were not accepted is the great difficulty in believing that anything could have the properties required of his aether. How could such a dense medium be present without its being obvious to us? **How could the earth or, indeed, one's own hand move through such a medium?** The existence of such a medium appears intuitively impossible. Part III of this paper, which is now being written, will try to answer the above question. It will also give simpler explanations for many poorly understood physical phenomenon.

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EDITOR'S NOTE: Put a mass in your fist, accelerate it and decelerate it rapidly. The **inertial** forces felt are a manifestation of the aether. The effect of energy causing the vacuum to emit proton-electron pairs is named the **Rowe Effect.**

ADDENDUM TO MECHANISMS OF A DISOBEDIENT SCIENCE

David Moon

Minnesotans have an expression they often use when observing someone who is fumbling with a supposedly simple or obvious situation: "It doesn't take a rocket scientist to...!" Hal Fox, editor for *Journal of New Energy* and a retired missile engineer, couldn't agree more. What is obvious in cold fusion is the replicable excess heat and nuclear products. But simple? No, that would take away the fun.

This article is an addendum to the parent paper, "Mechanisms of a Disobedient Science" [1]. The topics that will be addressed include proposals of reactions that might explain data from light water cells, and some metal transmutations in D_2O-Pd electrolysis experiments. Musings about microwaves and materials are made.

In "Mechanisms of a Disobedient Science", a spectrum of reactions in cold fusion cells based on the extent of invasion of oscillating deuteron trains into areas or regions ("windows") inside the metal atoms was offered as a means of tying together the seeming disarray of data from six years of cold fusion research. This spectrum of reactions from windows I-VI is again given in figure 1:

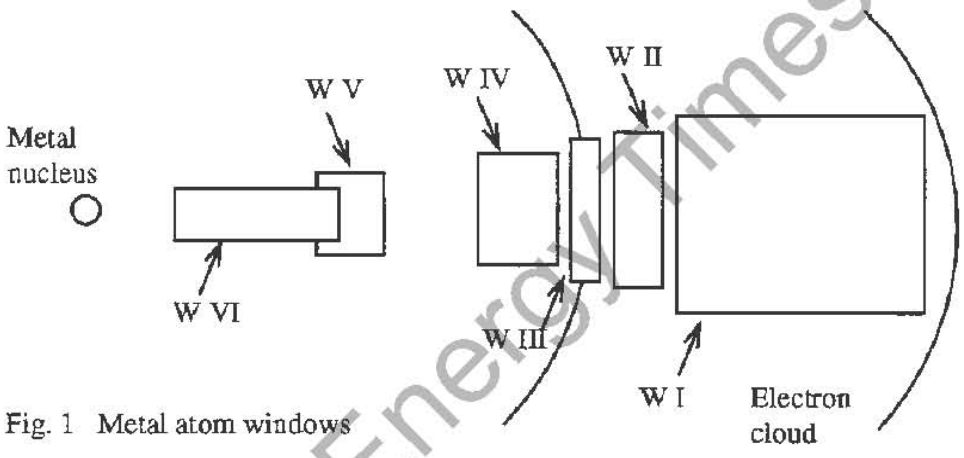


Fig. 1 Metal atom windows

Generally, each window will make possible the following reactions when the deuteron train invades into that region of the metal atom's volume:

W I - d+d fusion producing He-4, lattice heat.

W II - formation of "unstable dineutrons" (UDN), which can react with metal nuclei to bring transmutations

W III - conventional fusion of deuterium through partial electron screening

W IV - formation of tritium, which involves also a UDN formed by another deuteron trailing in Window II.

W V - formation of "stable dineutrons" (SDN), which can react with metal nuclei to produce transmutations, neutrons (3-7 MeV in Pd), and various fissions.

W VI - formation of energetic charged particles.

Which of these reactions occurs at any time within an active cell should depend on (1) the energy of the oscillating chain, (2) the compactness of chain, and (3) the degree of resonance or coherency of the oscillations. Some cold fusion cells will see all or most of the windows become active, while other cells will favor one or two windows.

This article will attempt to account for some cold fusion data not addressed in "Mechanisms of a Disobedient Science".

THE INTERMEDIATE NEUTRONS

One of the great challenges to theorists working in the new physics of cold fusion has been to find reasonable mechanisms to overcome the Coulomb barrier between deuterons, protons and large metal nuclei. Dr. Jean-Paul Biberian (Orinda, CA and Marseilles, France) has a concept of a "transient neutron." Dr. Biberian writes, "...for a very short time, the electron might orbit the deuteron in a transient orbit, which is not a Bohr orbit, and therefore it can be much closer to the nucleus than otherwise expected from a stable atom" [2].

Dr. Biberian's concept of such a neutral particle probably is very close to the proposed "unstable dineutron", or UDN(^{2}n*). This intermediate dineutron was predicted to form in window II of a metal atom during invasion of the deuteron train [1]. During invasion, the lead deuteron that just reaches into window II - which in a palladium atom is the inner region of the electron cloud - will experience the right amount of Coulomb excitation and therefore can become resonant with an inner - orbital electron of the metal atom (perhaps the K or L shell). If the P.E. (deuteron) + E(orbital e^-) is in a resonant wave state for a long enough time interval - about 10^{-14} to 10^{-12} second, the time of action of the weak electronuclear force [3] - then the electron can add to the deuteron in a weak bond to become a UDN.

The UDN will migrate toward the metal nucleus to react with it, or will meet with a rebounding deuteron (from window IV) to make low energy tritium:

(a) $^{110}Pd + {}^2n^* \rightarrow {}^{111m}Pd\ (0.04\ MeV) + (p + e^- + 3.33\ MeV)$

(b) $d + {}^2n^* \rightarrow t(recoil) + (p + e^- + 4.0\ MeV)$

In reaction (a), the Q - value is estimated by assigning an arbitrary value of E = 0.030 MeV in the reaction, $d + e^- + E \rightarrow {}^2n^*$ + neutrino. This is the input energy, P.E. (deuteron) + E(e^-), added during the weak capture of an inner - orbital electron by the invading deuteron in window II, forming a UDN. This value is strictly an estimation, and would be expected to range in the 10's of KeV. This approximation is based on the energy of the neutron that is believed to be occasionally formed in reaction (a) when the 0.782 MeV required to convert the ($p+e^-$) combination to a neutron is reabsorbed during reaction:

(c) $^{110}Pd + {}^2n^* \rightarrow {}^{111m}Pd\ (0.04\ MeV) + n(2.55\ MeV)$

Researchers measuring neutron energies sometimes have reported an energy band of 2.5 MeV to 7.0 MeV from PdD electrodes. Perhaps reaction (c) accounts for the low end of this energy spectrum. The rate of these neutron emissions was previously predicted to be approximately 10^{-9} of the reactions of Pd with ^{2}n* [1]. The same rate of 10^{-9} n/reaction was predicted for tritium production, reaction (b). This rate is based on the minimum neutron/tritium ratio typically reported in cold fusion experiments.

How close is the electron bonded to the deuteron in the UDN? Using the energy of 30 KeV in the UDN structure, the equation P.E. = Ze^2/r gives r= 48 fermis (4.8×10^{-12} cm) between electron and deuteron. At atomic and sub-atomic distances, another nucleus will see a neutral particle (^{2}n*) with which to react. (That is, in the ^{2}n* particle the captured electron is considered to add to and partly overlap with the deuteron, resulting in an effectively neutral particle.) Is the UDN equivalent to the mysterious "meshuganon" (from the Yiddish word meshuga meaning "crazy") that was suggested to possibly be the "yet undiscovered" neutral particle in cold fusion by Dr. Edward Teller in 1989? (see Fire From Ice, p 182)

Although it has been termed, in relative measure, an "unstable dineutron" in this theory, the UDN will have to be tight enough so as not to "rattle and fall apart" before it nears close enough (a few fermis or tens of fermis) to the metal nuclei to cause the various transmutations.

The counterpart to the UDN with heavy hydrogen is the "unstable mononeutron" (UMN) with light hydrogen. An UMN (n*) is proposed to form inside a metal atom when the oscillating proton train invades into window II of the metal.

In nickel atoms, window II would be placed closer to the nucleus and probably overlaps the region of window III (Fig. 1). In fact, it may extend to the region of window IV simply because further invasion of the proton chains is needed with a smaller nuclear charge (Z = 28) in order to reach the resonant energy state for making a UMN. For example, a proton sitting just outside the first Bohr orbit of a nickel atom (~2×10^{-10} cm) will experience a Coulomb potential energy of about 18.7 KeV (assuming K-shell electron screening). An electron from the L-shell, should it be captured by the proton to form a UMN, will carry an additional ~16.4 KeV.

Therefore:

$$p + e^- + E \rightarrow n^* + \text{neutrino}$$

where E = P.E. (proton) + E (e^-)
= 18.7 KeV + 16.4 KeV
= 0.035 MeV

If the resonant energy E happens to be larger than 0.03 MeV, window II will have to slide a little closer to the metal nucleus. A larger E - value might be expected based on the smaller size of the proton compared to the deuteron. Hypothetically, if E = 0.050 MeV, the captured electron abides at a distance of 28 fermis from the proton. Nevertheless, UMNs that form in light-hydrogen experiments are considered real neutral particles, as are UDNs that form in heavy - hydrogen experiments. Both kinds of intermediate neutrons can account for major data in their respective cold fusion experiments. They are especially big contributors in H_2- and H_2O - experiments where *light* means light water.

SOME LIKE IT LIGHT

It is already written into the history of science: The 1989 press conference by Drs. Fleischmann and Pons claiming fusion of heavy hydrogen at room temperature inside palladium electrodes sent a lightning bolt - a *coup de foudre* - through the world of nuclear physics. If that wasn't enough shock, the announcement two years later by Dr. Randell Mills of excess heat extracted from light water cells using nickel cathodes sparked more than light interest - and disbelief.

Replication and verification of the cold fusion effect in H_2- and H_2O- systems has been performed in many laboratories worldwide since 1991. Review of these is not necessary, but two analytical works will be cited to see if they can fit into the "spectrum of reactions" in this theory.

Seminal work of cold fusion by sparking in hydrogen gas has been done by Dr. Jacques Dufour, Shell Research S.A. (France). In a 1993 article [3], Dr. Dufour writes: "A concept different from electrolysis is used: the action of a high transient electrical field on hydrogen isotopes concentrated in the surface layer (few micrometers) of a metal in contact with a gaseous mixture containing hydrogen isotopes. The transient electrical field is created by sparking through the gas between two dissymmetrical electrodes, in which the surface layer of hydrogen isotopes is built... Precise and repeated energy balances show that excess energy is generated in the system, in a fully reproducible way. The amount measured on a steady-state basis (several days) excludes chemical or physical explanations. This excess energy production is observed with both hydrogen and deuterium and with various metals, even those forming unstable hydrides (iron, nickel), indicating a surface reaction... Indications of the emission of ß- particles have been observed... practically no tritium and no neutrons were detected."

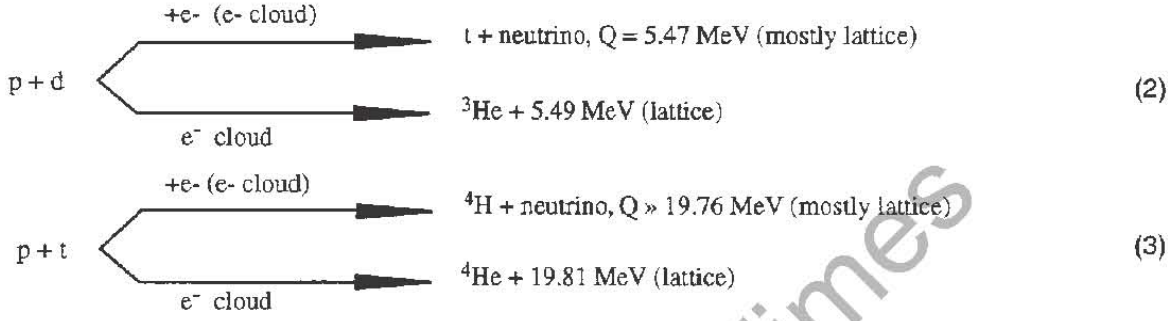
The essential reactions Dr. Dufour offered are given below, with some alterations adapting them to the model of deuteron (or proton) interactions with metal atoms during collective oscillations of linear chains against metal - atom barriers. These reactions are hypothesized to occur inside window I (toward metal nucleus).

For experiments involving light hydrogen:

$$p + p + e \xrightarrow{e \ \ cloud} d + neutrino \ , (Q = 1.442 \text{ MeV}) \qquad (1)$$

Here the e⁻ in the three-body fusion, orbiting within an inner electron shell of Ni (or other metal), draws (screens) the excited proton pair (which is part of the invading train of protons) into the "virtual neutron state" (p + n + neutrino) described by Dr. Dufour [3]. This state is 0.782 MeV higher than the (p + p + e⁻) state, so that the usual Q-value of 2.224 MeV released during the fusion of p + n → d has been reduced by 0.782 MeV. That quantum portion is reabsorbed during the (p + p + e⁻ → d) reaction, giving a net 1.442 MeV released. However, it is proposed this energy release is taken up mostly by the dense inner electron cloud of the metal atom, which is connected to lattice phonon vibrations. A minimum amount of energy is carried away by the neutrino.

As deuterons form in reaction (1), they may undergo subsequent reactions during oscillation of the hydrogen chain, inside the metal atom's electron cloud:



followed by:

$$^4H \rightarrow {}^4He + \beta^- + \text{neutrino}, \quad Q \approx 50 \text{ KeV} \tag{4}$$

The only significant nuclear activity recorded by Dr. Dufour in his $H_2(D_2)$-sparking experiments was low-energy bremsstrahlung events. Careful arrangement of sensitive x-ray films suggested that emission of beta particles were occurring in reaction (4) with an energy of about 50 KeV and a half-life of 20 minutes.

It is important to note that reactions (1)-(4) above, and reaction (5) below, will produce soft x-rays mentioned plus ultraviolet radiation (not detectable in the Dufour set-up) which are a result of electrons changing energy levels in the metal atoms from e- capture during fusion reactions.

In the case of sparking in deuterium, the cold fusion reactions proposed are (modified from Dufour):

$$d + d + e^- \xrightarrow{e^- \text{ cloud}} {}^4H + \text{neutrino}, \quad Q \approx 23.8 \text{ MeV (mostly lattice)} \tag{5}$$

followed by beta decay in reaction (4).

If a second electron is simultaneously taken up during fusion in reaction (5), quad-neutrons are produced:

$$d + d + 2e^- \xrightarrow{e^- \text{ cloud}} {}^4n + \text{neutrino}, \quad Q \approx 23 \text{ MeV (mostly lattice)} \tag{6}$$

Since an additional electron has been absorbed during d + d fusion to form ^4n, it seems reasonable to assume that this requires greater excitation, and thus will need further invasion of deuteron trains into the volume of metal atoms. Therefore, reaction (6) is predicted to occur in window II, but not likely in window I.

The Dufour paper revealed that "no gamma photons were detected" in their deuterium-sparking experiments [3]. Consequently, quad-neutrons were not manufactured in measurable numbers during deuterium sparking. When produced, they would be expected to cause gamma emissions after being captured by the host metal's nuclei. As an example, stainless steel electrodes could predict reactions such as:

$$^{56}_{26}Fe + {}^{4}n \rightarrow [^{60}_{26}Fe] \rightarrow {}^{56}_{24}Cr + {}^{4}_{2}He$$

$$\rightarrow {}^{56}_{25}Mn \xrightarrow[(2.5\ h)]{-\beta-\gamma} {}^{56}_{26}Fe \quad (-\beta-\gamma,\ 5.9\ m)$$

This brings the discussion to the second important analytical work with light-water cold fusion, at California State Polytechnic University in Pomona. (There are certainly other important research efforts in light water, such as the work by R. Notoya in Japan and M. Srinivasan in India.) Drs. Robert Bush and Robert Eagleton have used specially prepared nickel mesh cathodes with alkali-metal electrolytes in closed cells. Generous amounts of excess heat are consistently produced at an average of 1,000 percent excess power - a figure often quoted for H_2O-Ni experiments -for extended periods of time [4]. Dr. Bush's "Cold Alkali Fusion" hypothesis predicts, for example, the manufacture of calcium when potassium carbonate is used as the electrolyte. Dr. Bush's theory will be adopted to the reaction mechanisms presented here by employing the UMNs described earlier:

$$^{39}_{19}K + n* \rightarrow {}^{40}_{20}Ca + e^- + neutrino,\ Q \approx 8.35\ MeV \qquad (7)$$

(Q is estimated using mass of n* equal to 0.035 MeV greater than the mass of p + e^-, giving purely an approximation.)

The UMNs are predicted to form in window II and III, and possible also in window IV:

$$p + e^- \xrightarrow{e^-\ cloud} n* + neutrino \qquad (8)$$

Also, deuterons formed in reaction (1) above will occasionally be converted to UDNs which then can bring about transmutations; for example:

$$^{39}_{19}K + {}^{2}n* \rightarrow {}^{40}_{20}Ca + e^- + n,\ \text{or}$$
$$^{39}_{19}K + {}^{2}n* \rightarrow {}^{40}_{19}K + e^- + p,\ \text{or}$$
$$^{39}_{19}K + {}^{2}n* \rightarrow {}^{41}_{20}Ca + e^- + neutrino$$

Radiations in the form of UV and soft x-rays will be associated with reactions (7) and (8). In addition, characteristic x-ray lines from potassium and probably nickel would be emitted due to the action of energetic electrons generated in reaction (7). For example, the $K_{\alpha 1}$ - lines of potassium (3.31 KeV) and nickel (7.47 KeV) might be identified. However, x-ray detectors (or film) placed externally to the reactor probably will not receive these emissions, but x-ray film positioned inside the cold fusion cell, whether of light or heavy hydrogen, will be fogged by the soft x-ray emissions from reactions (1) - (8). Generally, only hard x-ray bremsstrahlung generated by fast electrons formed in reaction (7) would be detected outside a closed cell.

If reaction (7) were to explain essentially all of the excess heat from a K_2CO_3/H_2O/Ni cell in any particular experiment, then x-ray intensity would correlate with the excess heat, as would the calcium produced. The Bush/Eagleton experiments have given such correlations [4]. Nevertheless, the theory presented in this article must allow for reactions (1)-(3) to make a contribution to the excess heat, as well. In fact, in the absence of hard x-rays, these reactions become the sole account of excess heat.

What about H_2 gas - Ni systems in which alkali - metal salts are not present? This method can produce high rates of continuous excess power, too.
In reaction chambers containing gaseous light hydrogen with nickel electrodes, the model of proton - metal interactions from oscillations of long chains of hydrogen nuclei also is applied. Therefore, nickel can participate in all nickel - hydrogen experiments. A sample reaction is:

$$^{62}_{28}Ni + n* \rightarrow {}^{63}_{29}Cu + e \quad + neutrino, \text{ Q} \approx 6.16 \text{ MeV}$$

The appearance of copper and perhaps zinc in NiH systems is expected to occur in this theory, but only when UMNs form.

There might be another "nuclear" source of excess heating, which would produce nothing more than soft x-rays, at most:

$$^{58}Ni + n* \xrightarrow[-]{-e} {}^{58}Ni + p \text{ (about 200 KeV or more)}$$

Up to perhaps 200 KeV of kinetic energy is extracted when the UMN has its attached electron stripped, at a distance of about 200 fermis or less from the Ni-58 nucleus, followed by Coulomb acceleration of the exposed proton away from the metal nucleus - - which likely has no tendency to add the proton.

TRANSMUTATIONS IN TEXAS

Often in science, experiment is the chicken and theory is the egg. Experimental data can give birth to interesting and sometimes necessary ideas. But if experimental results are kept cooped up for a period of time, the theoretical idea that possibly could explain them might not hatch.

Such was the case in Pons-Fleischmann-type electrolysis experiments conducted in 1992 at Texas A&M University, in which Dr. Kevin Wolf found undeniable gamma-ray evidence for transmutation of palladium into several new metals six weeks after ending the electrolysis [5]. This revelation was hidden for three years - "politics," I understand - but was finally disclosed by Dr. Tom Passell, cold fusion program director at the Electric Power Research Institute, in a talk at ICCF5 in April, 1995 [see also *JNE*, vol 1, no 1, pp 9-14].

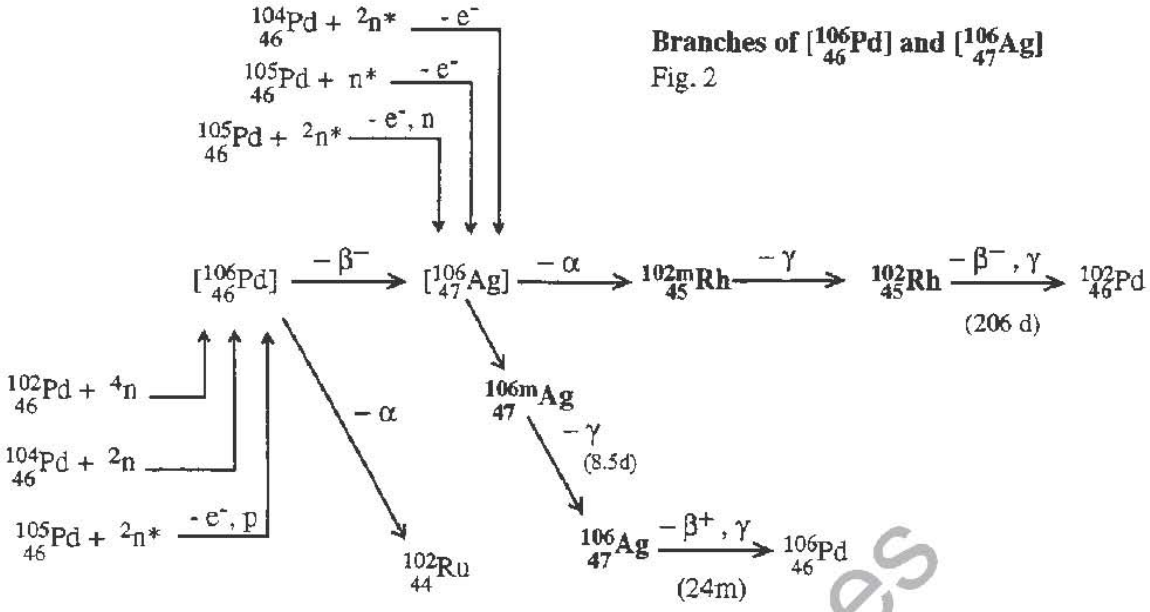
That which finally developed out of Dr. Wolf's data, as far as this theoretical model is concerned, is the idea of the possible production of quad-neutrons (along with other neutral particles: ^{2}n, ^{2}n*, n*), which could explain particular element shifts in Dr. Wolf's palladium cathodes. I want to emphasize, however, that this CF model is not the first to propose the formation of quad-neutrons. Dr. Takaaki Matsumoto, cold fusion researcher in Sapporo, Japan, is among probably several scientists who have postulated di- and quad-neutron activity in cold fusion cells [6].

In the Texas "hot" palladium cathodes, the identified new isotopes included:

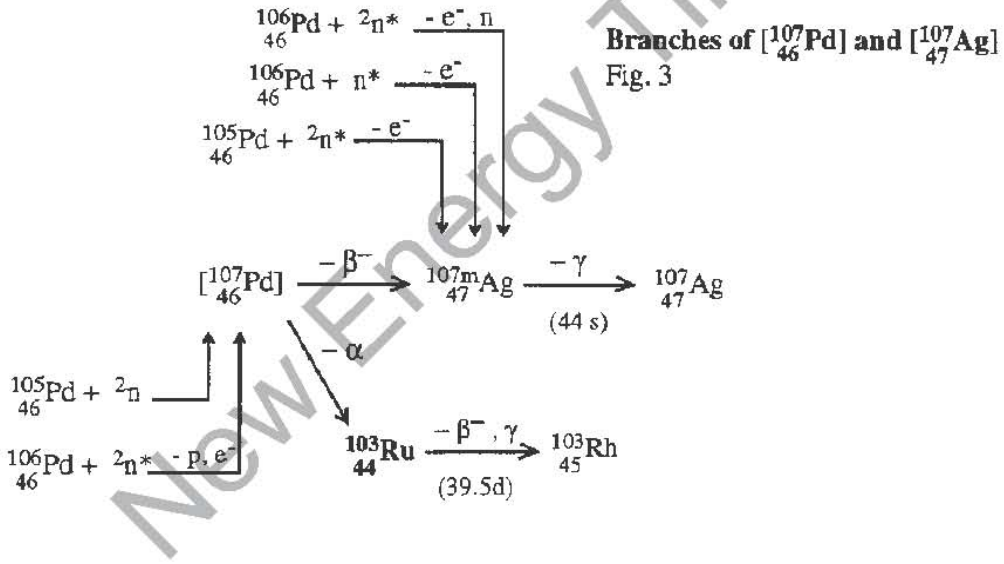
Silver 110m	Rhodium 102
Silver 106m	Rhodium 101m
Silver 106	Rhodium 101
Silver 105	Rhodium 99
Rhodium 102m	Ruthenium 103

How might these transmutations take place? Egged on by the reality of Dr. Wolf's data, Dr. Eugene Mallove wrote in his *Infinite Energy* article [5]: "For example, it would not be too far-fetched to imagine that some excited state of Pd-110 might emit a beta particle (changing a neutron to a proton) resulting in Ag-110. One might imagine that Ag-106 might be created via a similar mechanism... But how would rhodium-99 be obtained? One way, as Passell pointed out, would be to assume that a proton is absorbed by Pd-102, quickly followed by alpha emission. This would temporarily create Ag-103, and then Rh-99 upon ejection of the alpha particle, since an alpha particle consists of two neutrons and two proton. Still, many scientists find it difficult to accept that a proton could get close enough to interact with a larger nucleus, since both are positively charged and thus strongly repel each other via Coulomb repulsion."

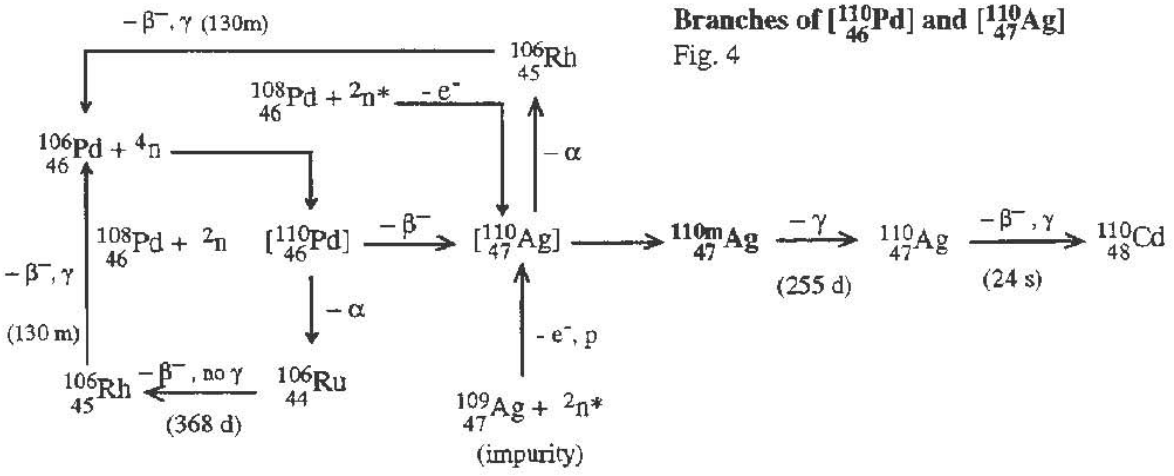
Reaction diagrams showing reactant and product pathways can be drawn for each of the palladium isotopes. Figs. 2 to 5 below illustrate four such sets of branches. Each branch will not be equally probable, but taken together they might account for the isotopes registered by Dr. Wolf. (Symbols in bold represent isotopes identified at Texas A&M, six weeks after terminating the heavy water electrolysis.)



Branches of [$^{106}_{46}$Pd] and [$^{106}_{47}$Ag]
Fig. 2

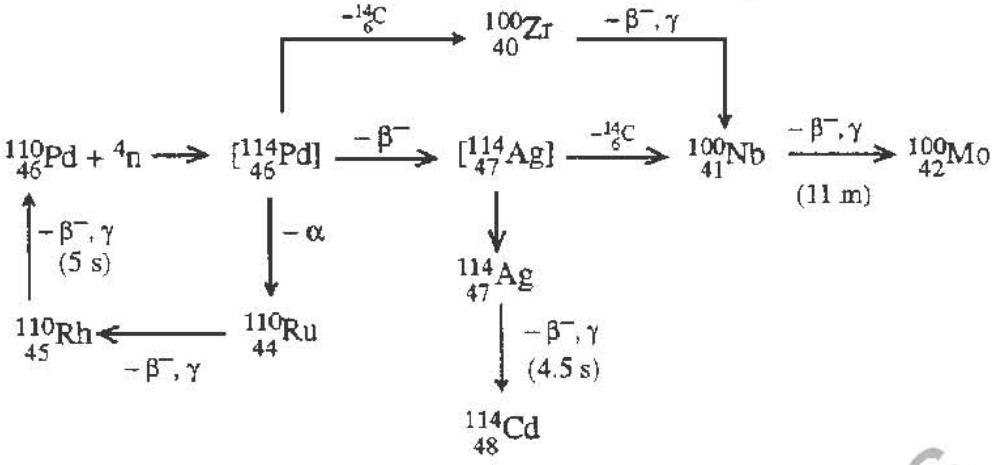


Branches of [$^{107}_{46}$Pd] and [$^{107}_{47}$Ag]
Fig. 3



Branches of [$^{110}_{46}$Pd] and [$^{110}_{47}$Ag]
Fig. 4

Branches of $[^{114}_{46}Pd]$ and $[^{114}_{47}Ag]$
Fig. 5



PICKET FENCES

On July 29, 1995 on "the Laura Lee Show - live!," I listened to KSTP-AM from St. Paul, Minnesota. Hal Fox was the special guest. A caller was interested in cold fusion materials. In his own home-spun way, Hal, who is one of the most widely knowledgeable gentlemen in the cold fusion field, answers, "the materials that work best are like picket fences - single crystals." Dr. Edmund Storms, who is an expert on cold fusion materials, calls cold fusion "one of the greatest discoveries of the last several centuries."

This cold fusion theory has taken the approach that to have an active cold fusion electrode, it helps to "have all your ducks in a row," that deuterons or protons packed into an active volume (active surface) of the cathode will assemble themselves into highly ordered layers which are "plasmodial" and mobile, making possible collective, coherent oscillations of chains of the hydrogen nuclei against metal-atom barriers.

With this necessary arrangement of mobile deuterons, it is not unusual that larger single-grain crystals work best in cold fusion cells. The picket fence idea of crystal structure seems plausible to help organize deuterons or protons into long chains. (Surface catalysis is also a factor, and may help explain why nickel, titanium, tin, gold and other metals work so well with light hydrogen.)

Jean-Paul Biberian summarized his concept of "strings of deuterons" by stating: "The quality of the host lattice is important. Single crystal grains must be large enough to accommodate long strings, probably several microns in length... It is harder to make a linear string in a three dimensional world than in a two or even one dimensional one. Perhaps laminar materials are more suited for that, like high-temperature superconductors, or graphite-type compounds. Even better could be the use of zeolites, some of which are excellent proton conductors, that have one-dimensional structures." [2]

Is the layered, linear (parallel) structure of graphite, for example, a helpful agent to line up long trains of protons to do "microwave sonoluminescence"? Warren Cooley and Chuck Bennett recently reported "the discovery of microwave sonoluminescence in a matrix of activated carbon. Experiments with common graphite treated with liquid water then subjected to microwave radiation [using an ordinary kitchen microwave oven] reveal small bursts of light very similar to the sonoluminescence effect in cavitation bubbles." [7]

Mr. Bennett and Mr. Cooley write further comments that I believe should be given consideration: "The presence of free individual carbon atoms seem to add to the effect. When dry graphite is preheated in the microwave oven, the carbon structure is annealed into a weak crystalline structure that is nonhygroscopic thereby short circuiting the effect. Activated carbon with loose individual carbon atoms retains water vapor on the surface and in the micropores of the carbon structure. Then microwave radiation disassociates hydrogen from the water. Then some, as yet unknown, transmutation or fusion takes place."

There might be something to the notion that water molecules absorbing resonant microwave energy — dislodging protons at a catalytic surface to undergo collective oscillations — can focus the available energy into a wave pulse along the proton chain, resulting in sufficient excitation at the "point of attack" to cause effects like sonoluminescence or cold fusion reactions.

The collective energy of the hydrogen chains is important. For example, a total energy of about 270 KeV could propel the chain into Window V of a palladium atom. Window V is the region inside the volume of the metal atom where stable dineutrons (SDNs) form. Instead, if the invading deuteron or proton chain were to immediately rebound from the large Coulomb barrier of the metal nucleus, any of the various fusion reactions previously described would be possible with the help of electron screening inside the metal atom's electron cloud. It is the amplitude of the oscillating chain, determined by the total energy, as well as the compactness of the chain that determines (1) the extent of invasion into the barrier metal atom, and (2) which of the reactions (windows I - VI) will occur. Selecting the preferred heat-producing reactions (in windows I and II) is a matter of finding the correct energies and frequencies for the oscillating chains. Of course, the first step is to build the chains. That is why high surface and near-surface loading is required.

CHAIN LINKS?

The view has been expressed by several scientists that high-temperature superconductivity (HTSC) and cold fusion have one thing in common: they are both collective phenomena. In the case of HTSC, the Bardeen-Cooper-Schrieffer (BCS) theory talks of Cooper-pairs of electrons. Perhaps even Cooper chains are possible. Dr. Millennium Twain of Menlo Park, CA, who is working on a book, The Undiscovered Physics, wrote: "...[Cooper-pair] electrons are not congruent space-wise, but are distantly paired with opposite spins and magnetic moments. That is why it seems to me to be related to atomic electron s-shell pairs. ... They say the pairs are generally 's-wave' (phonon mediated), but sometimes 'd-wave' or 'p-wave' (non-phonon mediated)" [8].

Figure 6 is an attempt to represent phonon-mediated Cooper-electron pairs (interpretation from Twain):

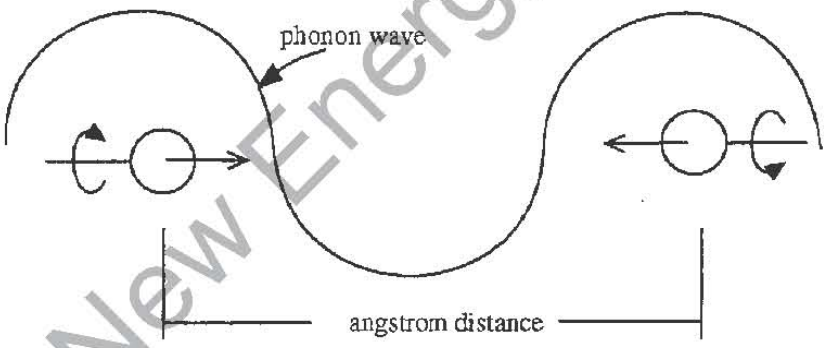


Fig. 6 Linear (Phonon - mediated) Cooper Electron-Pairs

Dr. Twain is also considering additional pictures of Cooper pairs, and admits (as does this author) only to "not too rigorous speculations" at this time.

In the case of at least neighboring s-electrons in the lattice of a superconductor, it is reasonable to believe that the material is able to build chains of Cooper pairs when the temperature is lowered to the critical temperature, because at T_c coherent domains in the lattice have enlarged and "grown together" so that phonon vibrations are coherent on a larger scale and encompass a much larger domain. The s-electron band becomes a macro quantum element - a single entity.

One interesting difference between HTSC and CF is the response to an applied magnetic field. A magnetic field eventually breaks down HTSC, but has been shown to enhance cold fusion. In the case of HTSC, perhaps it can be assumed that an outside magnetic field orients the Cooper-pair electrons N-S - - - N-S, so that their spins suddenly violate the requirement of zero net magnetic moment, breaking the bound pairs.

For cold fusion cells, it would seem that an applied magnetic field also would destroy any existing Cooper-pairs of protons or deuterons for the same reason. This fate does not encourage a theory of Cooper chains of protons in cold fusion. Instead, the simple explanation is to assume that the magnetic field helps align deuterons or protons in the oscillating chain (to make a straighter chain), and Cooper pairs are not required (though they still might exist), therefore zero net spin is not the issue in the chains. The hydrogen nuclei tend to follow the magnetic lines. If this elementary interpretation is true, could this explain the increased efficiency of Ni-H_2 systems, in which the ferromagnetic property helps form linear arrangements of protons on or near the nickel surface?

Indeed, if protons or deuterons lined up in a chain can become unidirectional in their spins, the oscillating chain has a net magnetic moment of its own when immersed inside a magnetic field. Thus, a hydrogen-loaded electrode should exhibit a stronger magnetic field, induced by the applied field, than a hydrogen-free electrode. Of course, this assumes chains have been allowed to build. It would be very interesting if the effect could be measured experimentally.

PROOF IS IN THE PUDDING

In *IE* issue #3, ideas for test electrodes were suggested [1]. They involved application of microwave energy. Another idea is to use crystal structures that promote the building of deuteron or proton chains, perhaps in conjunction with properly oriented magnetic fields.

Tin metal has been effective in light water experiments. Tin comes in two structures: cubic (gray) and tetragonal (silver-white) and probably has special surface-catalytic properties. No doubt there are enough experts in materials, surface catalysis and other engineering skills to assure the development of the most promising cold fusion devices. These devices, I believe, will be guided by the goal of trying to form long chains of hydrogen nuclei in the surface layers of pure, large-grain crystals having a large surface area. The chains are expected to oscillate collectively and coherently in and out of large-metal interfaces or boundaries. These oscillations may be modified by a microwave frequency of varying intensity.

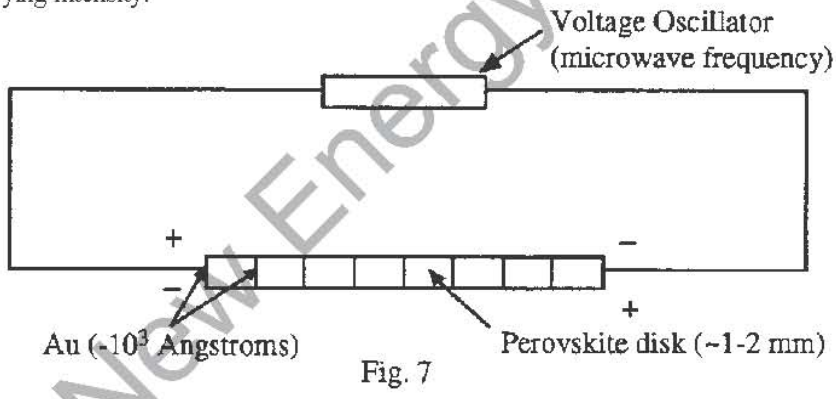


Fig. 7

Proton-conducting perovskites seem to be a promising alternative to palladium or titanium electrodes, as many experiments have shown. I understand the overall deuterium loading is small but may be locally dense. The hypersensitive performance of experiments is due, in part, to the random appearance and disappearance of these locally dense regions, where deuteron concentration is above a threshold level for reaction. Some researchers use pulsed voltages to drive the protons or deuterons through the ceramic oxide, presumably to create what Dr. Eichi Yamaguchi calls "accumulation layers." He achieved concentrated layers of deuterons employing palladium foils coated with gold on one side and manganese oxide on the other.

Therefore, a proton conductor might be constructed using alternating layers of gold and ceramic oxide for the purpose of building accumulation layers of deuterons, as in Fig. 7. After deuterium has been introduced into the perovskite disks, the approach would be to create coherent deuteron oscillations back and forth against the gold barriers, rather than driving deuterons through the material in one direction only. Perhaps this can be accomplished with the application of an oscillating voltage at the resonant microwave frequency of the trains (or chains) of deuterons. Then reaction mechanisms described previously can occur as long as the accumulation layers at the gold - perovskite interfaces are maintained.

As reactions continue, more deuterium should feed into at least the surface layers of the perovskite disks in the D_2 - gas-filled chamber, which is operating at an elevated temperature (400 °C). A near-surface active volume might

be all that is needed (P. Glück, "Surface Dynamics"). Dr. Mizuno's first sample, which melted, was judged by him to have done so during the first minutes after starting his experiment, implying a near-surface event [9].

TINY BUBBLES

Thus far in this theoretical model, collective oscillations of long chains of deuterons or protons against metal-atom barriers have been used to explain essentially all nuclear phenomena and excess heating from cold fusion experiments of varying types. This includes the cavitation methods of Roger Stringham and Russ George (sonoluminescence) and James Griggs (Hydrosonic Pump™). In this theory, cavitation action serves as a means of loading surface layers of metal structures with plasmodial hydrogen nuclei. Post - run analysis of the metal surfaces reveals the degradation by the cavitation effects.

The Yusmar thermogenerator, using a vortex cavitation mechanism, does not show the same wear and tear in its pump, motor or vortex tube. Developed by Dr. Yuri S. Potapov (Kishinev, Moldova), this commercially distributed unit claims to perform at 3-10 times the amount of heat out as energy in. After his interview with Dr. Potapov, Christopher Tinsley reported, "A vortex is established in the liquid in the tube. The velocity gradient within the liquid is so great that cavitation occurs - not between the liquid and the tube wall, but between adjacent layers of liquid. This is, of course, reminiscent of the Griggs Hydrosonic machine, but in that device the cavitation is induced by shear between metal and liquid, not between layers of liquid." [10]

The most curious question becomes, "Is it nuclear?" Some advanced theories involving mass-energy conversions have been given, most notably by Prof. Lev Sapogin (Moscow) [11], and by Dr. Hal Puthoff (Austin, Texas) whose theory of producing excess energy involves extraction from the quantum fluctuations of space, that is, the electromagnetic background (Zero Point Energy) [12].

In a letter to *Infinite Energy* [13], Dr. Talbot Chubb of Arlington, Virginia, writes, "Getting heat from ordinary water seems a bit improbable, except when you think of the conditions existing during cavitation: 50 atm of pressure for 10^{-9} s, water - compression - heating raising the water temperature to 120°C, with some of the water crystallizing to ice VII. Lots of shock wave excitation to put all kinds of ions into excited states, which with a solid, and maybe even with a liquid could mean band state occupations."

In the Potapov thermogenerator device, where cavitation occurs between liquid layers and not at the metal surfaces, the highly compressed wall in the collapsing bubble will take the place of grain boundaries. If pure water constitutes the liquid in the Potapov vortex cavitation chamber, it may be the oxygen atoms that will be invaded by the trains of energetic protons, which then provide the electron clouds for screening.

As in the earlier discussion of these reactions, soft x-rays and UV radiation are a required byproduct. Chris Tinsley reported on the Potapov machine: "Thorough searches have been done for x-rays, gammas and neutrons, with nothing found. Admittedly, some lower energy particles might fail to penetrate the thin wall of the Yusmar machine..." [10].

The UMNs (n*) formed have free access to the oxygen nucleus. In a related article discussing light water and cavitation methods [14], Drs. Talbot and Scott Chubb offered the following reaction:

$$^{1}H + {}^{18}O \rightarrow {}^{19}F + 8.0\ MeV$$

They gave the "abundance ratio $^{18}O/^{16}O = 2x10^{-3}$ in H_2O, as compared with $D/H = 10^{-4}$ which favors the ^{18}O reaction [over the impurity D+D fusion]..."

In the same publication [14], a proposed reaction by Alan DeAngelis (Pennington, NJ) is reviewed:

$$^{2}H + {}^{17}O \rightarrow {}^{4}He + {}^{15}N,\ Q = 9.8\ MeV$$

Both of these oxygen fusions can easily occur in this model using the UMNs or UDNs that form inside the oxygen atom's volume:

$$^{18}O + n^* \rightarrow {}^{19}F + e^- (\sim 8.0\ MeV)$$

$$^{17}O + {}^{2}n^* \rightarrow {}^{4}He + {}^{15}N + e^- + 9.8\ MeV$$

Interestingly, it has been recently reported that researchers "produced some fluorine from water vapor using electric and magnetic fields." [15] A desirable but perhaps improbable measurement would be detection of fluorine in mechanical cavitation water supplies, such as the Potapov device - improbable because of the large bulk material involved.

Comparing the cavitation methods of Griggs or Potapov with Stringham/George, it is fair to conclude (or at least speculate) that, although their (Stringham/George) deuteron chains have had a chance to form, their proton chains (which need to be more compact) do not have enough time to form in the very rapid cycle of the ultrasound waves. The Griggs and Potapov methods of agitation create oscillations that are slow enough to build the transient proton chains in H_2O.

CHAINS AND DOMAINS

Organization of matter is actually organization of energy, since matter is condensed or focused energy. What we call "structure" (e.g. metal lattice, molecules in a liquid) is a manifestation of the assembly of "energy bands" (ref. T. Chubb) of the electromagnetic - particle field which consists of multiple frequencies and harmonics. The energy bands or states are stable - and the imbedded "material" is stable - to the extent that the energy bands are self-resonant. The condensed form of energy we call matter, therefore, is an alignment (yielding a "structure") of various energy bands (which have linear propagation, it is proposed) that are collected into *coherent domains* (credit G. Preparata) of variable size. The degree or extent of coherency of a body is termed entropy (rather, *anti*entropy). That is, greater coherency of the energy bands and their domains equals lower entropy.

The consequence of these coherent energy bands is to describe macroscopic thermodynamic properties as being related to "the existence of long range electrodynamic interactions [the energy bands themselves] which are able to organize atomic systems on large scales [the coherent domains]. A purely atomic description of condensed matter appears untenable." [16].

A body at low entropy consists of fewer (but larger) coherent domains as well as fewer possible energy bands that can be occupied. A body at high entropy consists of more and smaller coherent domains and has a greater number of possible energy states.

Liquids also consist of coherent domains (albeit smaller size) of specific energy bands in a string-like fashion multiplied over and over. Thus, it is perhaps not unusual that hydrogen on or near the surface of a metal lattice (the active sites) will migrate and oscillate as a "proton liquid" within a quantum energy band.

A suggestion of this kind was given by C. Battolomeo, M. Fleischmann, et al., in a paper at ICCF4 in Hawaii [17]. The authors point out that, "The protons (or deuterons) are in a collective state described by macroscopic quantum mechanics so that they can experience intense anharmonic excitations."

In a recent paper, William S. Page treats liquid water in the context of proton conductors [18]. His concepts seem to parallel ideas presented in this and the previous article [l], in which linear chains of deuterons or protons, at or near the cathode surface, are considered to be a single, mobile (conducting) entity.

Dr. Page writes:

> *"In any situation in which a particle moves in a periodic potential, the energy states of that particle are constrained to occur in "bands", i.e. groups of closely spaced discrete energy levels separated by "gaps" or forbidden energies. Each band contains the same number of states - equal to the total number of unit cells in the "lattice", i.e. the number of potential wells in the periodic structure... The lowest energy band is called the valence band. It is the valence band that is responsible for the structural stability of the material. Since protons are spin 1/2 particles, Fermi's exclusion principle allows for two such particles (in opposite spin states) to occupy each energy level. In the case of water, each unit cell (molecule) contributes two protons to the valence band. Therefore, as in the theory of electronic semi-conductors, we can see qualitatively that at absolute zero temperature water should be a proton insulator. All the potentially mobile protons would be in the valence band and this band would be full - a moderate potential difference is not able to change the energy level of (that is, to accelerate) these protons. At 0°K, the higher energy bands (the conduction bands) are all empty. As the temperature is increased, a small number of the protons from the valence band can be excited across the energy gap into the conduction bands (or equivalently, we say that auto-ionization occurs: $2H_2O \Leftrightarrow H_3O^+ + OH^-$)."*

PREDICTIONS FULFILLED SOON

The development of the hypothesis presented in this paper and in the earlier article [1] has benefited immeasurably from a wide spectrum of consistent, albeit bizarre, data from a great variety of experiments. Also beneficial have been the important and insightful theoretical concepts written by creative thinkers in cold fusion.

The predictions given at the International Conference on Peaceful Uses of Atomic Energy (Geneva, Switzerland, August, 1955) may soon be fulfilled [19]:

> *"When we learn how to liberate fusion energy in a controlled manner, the energy problems of the world will truly have been solved forever, for the fuel will be as plentiful as the heavy water in the oceans."*
> -Professor Homi J. Bhabha,
> then head of India's Atomic Energy Commission, and president of the Conference.

> *"My faith in the creative ability of the scientist is so great that I am sure that this [power from fusion] will be achieved long before it is essential for man's needs."*
> Sir John D. Cockcroft
> (with E.T.S. Walton produced first artificial transmutation by man-made projectiles, 1932).

Dr. Cockcroft was nearly correct. Cold fusion is being achieved *not* long before the need - for the need is here. And the form (cold, not hot) is different than perhaps originally envisioned. Nevertheless, fusion has arrived! So, congratulations are in order, first to Martin Fleischmann and Stanley Pons, then of course ... et al.

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SEGNER-MARINOV TURBINE AS A PERPETUAL MOTION MACHINE

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ABSTRACT

I devise the historic Segner turbine as a system with a closed energetic circle. If leaving the water in Segner's turbine to have a paraboloidic surface and if pouring the squirted out water into its centre (in such a case I call it the Segner-Marinov turbine), the system becomes self-accelerating. The energy win comes from the "tunnel transition" of water under the hydrostatic "potential barrier."

DISCUSSION

Johann Andreas Segner (1704-1777) invented the so-called Segner's reaction wheel which can be considered as forerunner of the hydraulic turbines, although Segner's turbine differs **substantially** from the turbines constructed by today's engineers. Many persons who have tried to calculate the efficiency of Segner's turbine obtained figures higher than 100% (the illustrious mathematician Leonhard Euler obtained an efficiency of 400%) but, to the best of my knowledge, a **good** Segner's turbine with **closed** energetic circle was **never** constructed.

Segner's turbine was always a puzzle and until the present day it remains a puzzle (for these people who still have not forgotten this stupendous invention), as one is unable to give a clear answer whether it violates (or does not violate) the energy conservation law.

With the aim to discuss the physics in Segner's turbine in the most simple and didactic way, I represent it in Fig. 1 as a system with closed energetic circle.

The **cylindrical** tank A, with radius R and height H, which at its bottom has an axial cylindrical hole, bordered by a tube with height lower than H, can rotate with low friction about its vertical axis. The **ring** tank B, which is fixed to the laboratory, encircles tank A and is connected to a tube which enters into the axial hole of the latter. If this tube will be filled with water until its border, the water begins to drop into tank A. The upper drawing represents the horizontal cross-section.

First one sets tank A in rotation with a certain velocity and then one begins to fill it with water through its upper hole which is eccentric with respect to the tank's axis. A part of the water begins to fill tank A and a part squirting out through the nozzles arranged circumferencially at its bottom begins to fill tank B. Only one of the nozzles is drawn in the lower figure, as well as its water jet. Of its symmetric nozzle (displaced at 180°) only a part of the water jet is shown.

The nozzles makes an angle θ with the horizontal plane, so that the water jets leave the nozzles also under the same angle.

After a certain time, when the water from tank B via the radial pipe(s) and the vertical axial tube begins to drop in tank A, one stops the water supply and leaves tank A to rotate inertially. The experiment shows that the surface of rotating water is paraboloidic and in Fig. 1 its axial cross-section is shown. The net pressure, P_{net}, at any point of this surface, obviously, must be constant and equal to the **scalar** sum of the gravitational and kinematic pressures

$$P_{gr} = \mu g h, \qquad P_{kin} = (1/2)\mu\Omega^2 r^2 \tag{1}$$

where μ (= 1000 kg/m^3) is the density of water, g (= 9.81 m/sec^2) is the gravitational acceleration, Ω is the angular velocity, h is the deepness of the point considered and r is its radius. Indeed, easily can be seen that

$$P_{net} = P_{gr} + P_{kin} = (\mu/2)(2gh + \Omega^2 r^2) \tag{2}$$

remains constant along a parabola: equalize the right side of (2) to μgH and put then H - h = y, r = x; for the constant in the parabola equation $y = kx^2$ we shall have $k = \Omega^2/2g$.

The velocity of the water jet leaving the nozzles will be (Torricelli)

$$v^2 = 2P_{net}/\mu = (2gH + \Omega^2R^2). \quad (3)$$

If the outlets of the nozzles are parallel to the horizontal plane, the torque, with which a unit **volume** of water squirting out in a **unit of time** that will act on tank A, will be (v is the water's velocity respectively to the tank's circumference):

$$(M_{dr})_{V=1\,m^3/\mathrm{sec}} = R\,\mu v \quad (4)$$

If the volume of water squirting out from the nozzles in a unit of time is V, we shall have for the torque acting on tank A

$$M_{dr} = \mu v R V . \quad (5)$$

For the case that the nozzles conclude an angle θ with the horizontal plane, we shall obtain the driving torque by multiplying (5) by cosθ. The sine component of the jet will act on the bearings of the rotating tank.

Let us suppose that the diameter of the vertical tube is very small with respect to the radius R of the cylindrical tank and that the angular velocity Ω is so high that there is no water at the centre of the tank. In such a case, we shall have θ ≅ 0, and proceeding from formulas (5) and (3) we can write

$$M_{dr} = \mu(2gH + \Omega^2R^2)^{1/2}RV . \quad (6)$$

If we shall assume $2gH << \Omega^2R^2$ we shall have for the driving torque

$$M_{dr} = \mu\Omega R^2V . \quad (7)$$

The braking torque, M_{br}, will be generated by the Coriolis forces acting on the water which drops from the axial tube with a linear velocity v = 0 but at the periphery has a linear velocity v = ΩR.

As the Coriolis acceleration acting on a mass moving with a radial velocity v over a disk rotating with an angular velocity Ω is u = 2Ω x v, the torque executed by a unit volume of water moving from the centre of the disk to its periphery with a velocity v = **R in a second** will be

$$(M_{br})_{V=1m^3/\mathrm{sec}} = \int_0^R r\mu 2\Omega v\,(dr/R) = 2\mu\Omega \int_0^R rdr = \mu\Omega R^2 . \quad (8)$$

As in a unit of time the volume of the streaming water is V, we obtain for the braking torque

$$M_{br} = \mu\Omega R^2V , \quad (9)$$

a value which is numerically equal to the value of the driving torque (Eq. 7).

Establishing this equality, it seems that the energy conservation law has been saved, as the velocity of water with respect to the circumference of tank A is v = ΩR, however with respect to the laboratory it is equal to zero.

But there is also the action of the gravitational pressure P_{gr} which will increase the velocity of the squirting out water to the value (3). Thus the angular velocity of tank A will increase over the initial value, Ω, to a new value Ω_1 higher than Ω. This will lead to an additional increase of the velocity of the squirting out water over the initial value (3). This from its part will lead to a further increase of the rotational velocity, etc.

In the book published in 1750, where only tank A is considered completely filled and water is continuously supplied via the upper inlet, Segner wrote:

> ... diese Bewegung wird immer schneller und schneller und kann endlich einen jeden Grad von Geschwindigkeit erreichen. Zugleich wird auch der Ausfluss des Wassers immer stärker und stärker, also muss der Zufluss ebenfalls wachsen, wenn man das Gefaess gleichvoll erhalten will.

I have, of course, to add that the rotational velocity will continue to increase only in the case where the friction moment, M_{fr}, will remain lower that the moment $M_{dr} - M_{br}$ [see (6) and (9)]. If $M_{fr} = M_{dr} - M_{br}$, the rotation will be stationary. And if $M_{fr} > M_{dr} - M_{br}$, the rotational velocity will begin to decrease.

Thus, at the condition $M_{fr} = M_{dr} - M_{br}$, Segner's turbine in the variation shown in Fig. 1, which we can call the **Segner-Marinov turbine**, will rotate **eternally**. One has only to care to pour every now and then some water which has to substitute the inevitable losses due to evaporation.

Why can one realize a perpetual motion machine by the help of the Segner-Marinov turbine? - The answer is obvious:

In the Segner-Marinov turbine we use the pressure of water of the whole height H, but we have to lift the squirted out water to a lower height which easily can be reduced practically to zero. When water drops into tank A, it will immediately be distributed over the whole paraboloidal surface, but the **vertical** lift of water does **not** generate braking torque. It is only the **radial** transfer of water which generates a Coriolis torque.

I have to add, however, that nobody has done measurements to see whether the Coriolis force acting in the Segner-Marinov turbine will be the same as when a solid mass moves along the radius of a rotating disk. By the help of simple speculations I came to the conclusion that the Coriolis torque of water **streaming in water**, as is the case in the Segner-Marinov turbine, must be less than the theoretical value (9). Of course, only the experiment can give the definite answer.

Which conclusion can we draw after analysing the physical essence of the Segner-Marinov turbine? Obviously the conclusion is only one: Mankind, which during centuries constructs waterdams whose dimensions and costs can be compared only with those of the Egyptian pyramids, is nothing else than a blind herd. The inutility of these dams can be compared only with the inutility of the pyramids.

EDITOR'S NOTE: For further discussion and a picture of the Segner turbine (c 1750) see *Deutsche Physik*, July-Sept 1996, pp 17-26.

THE ZERO POINT INTERACTION

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May 1996

ABSTRACT

The principle of the conservation of energy states that energy is neither created or destroyed, the total energy in the universe remains constant. It is commonly believed that the principle of the conservation of energy forbids the creation of something out of nothing. This author has shown that the constant of energy contained within the universe is zero. [1] The positive energy of the universe is balanced by an equivalent amount of negative gravitational potential. In brief, if matter could fall into the universe from an infinite distance away it would loose an amount of gravitational potential energy equal to its rest energy. It appears that the principle of the conservation of energy does not forbid the creation of something from nothing. Energy, however, does not universally spring from the vacuum. What then inhibits the process of creation? An answer to this question can be found in another conservation law, the conservation of angular momentum. A photon has a spin of one and a graviton has a spin of two. A process in which a spin one photon and a spin two graviton are simultaneously emitted does not conserve angular momentum.

The defining property of a zero point system is its angular momentum. The angular momentum of a zero point system is an integer multiple of Planck's constant. A vibrational mode known as a phonon exchanges angular momentum within a zero point system. The transfer of angular momentum within a zero point system facilitates the spontaneous formation of a spin one and a spin two field. Superconductors and superfluids are two types of zero point systems. The study of cryogenic systems is very instructive. A better understanding of all zero point systems can be gained through this study.

The nuclear reactions and isotopic shifts that occur in cold fusion experiments are unusual and unexpected [2]. These reactions do not produce any signatures. A fundamental change in the interaction of the forces takes place in a zero point system. This change permits the unexpected nuclear phenomena to occur [3].

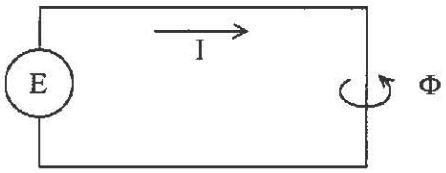
INTRODUCTION

It is well known that superconductors offer no resistance to electrical currents. Less well known, but even more amazing, are the low temperature superfluids. These fluids flow without friction. Once set into motion, they never slow down. Quantum interactions are limited to atomic distances in normal substances. In superconductors and superfluids quantum interactions are observed on a macroscopic scale. The normal interaction of the magnetic and electric field is very different in a superconductor. In normal conductors dynamic changing fields are required to induce other fields. In superconductors static fields can also induce other fields. The sum of these phenomena reveals a unique underlying processes. A fresh look at this process leads to a deeper understanding of the zero point interaction.

THE ELECTROMAGNETIC FIELD

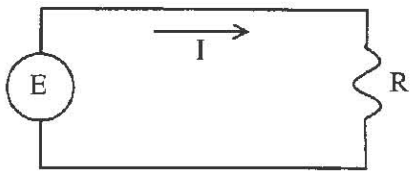
The relationship between the electric and the magnetic field has been known for many years. A very important, but often overlooked, aspect of this relationship is the independence of the two fields. The fact that a static magnetic and static electric fields can exist alone independently of each other is a very important property of the fields. For example, a capacitor can have a static electric field while not possessing a magnetic field. Likewise a bar magnet can have a static magnetic field while not possessing a net electrical charge.

In resistive circuits the electric field is isolated from the current flow by resistor "R." For example, if resistor "R" has an infinite resistance no current will flow and no magnetic field will be produced. In a resistive circuit the electric and the magnetic fields have a life of their own.



The Superconductive Circuit

Fig. 1



The Resistive Circuit

In the superconductive circuit the resistor, "R" no longer exists. The electric field is dependent on the changing magnetic field "Φ." The strength of the electric field varies directly with the strength of a changing magnetic field. In a superconductor, the electric and magnetic fields are always coupled together. They do not have separate existences. To confirm the nature of the coupling the result of an experiment done by W. Meissner in 1933 will be reviewed. In this experiment, a ordinary loop of wire is inserted into a magnetic field. Fig. 2 shows a coil that was moved from position "A", outside of a magnetic field, to position "B", inside of a magnetic field. As expected a loop current is induced in the loop as it cuts the lines of flux. This loop current dies down in time. This time period (t) is determined by the intrinsic inductance (L) and resistance (R) of the loop.

$$\textbf{Current final} = \textbf{(Current initial)} / e^{(tR/L)} \quad (1)$$

The first loop of ordinary wire is removed and a superconductive loop is now inserted into the magnetic field. Fig. 2 again depicts the loop being moved from position "A" to position "B." As expected, the loop current persists undiminished after the loop comes to rest at position "B." This undiminished current is represented by

Current final = Current initial (2)

The first experiment is repeated and a non-superconducting loop of wire is inserted into the magnetic field. The current is again allowed to die down. See equation (1). After the current drops to a value of zero, the stationary loop (loops remains in position "B") is cooled until it becomes superconductive. What happens? Equation (2) predicts that the current should remain fixed at zero. Astonishingly, the loop current reappears. [4] In a superconductor a steady state magnetic field is in all cases symmetrically balanced by a steady current. Symmetry is restored to the laws of electromagnetic induction. The element of time is not a factor in the cryogenic electromagnetic relationship. The independence of the electric and the magnetic fields is lost at cryogenic temperatures. The electric and magnetic fields merge together and act as a unified single force.

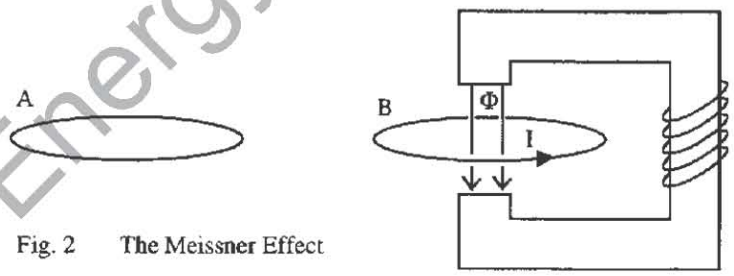


Fig. 2 The Meissner Effect

THE QUANTUM & NUCLEAR FORCES

All forces, within a zero point system, should display the same general tendency to merge. See Fig. 3

The quantum forces normally have a very short range of interaction. This range is confined to atomic dimensions. Quantum interactions are observed on a macroscopic scale in superconductors and superfluids. Superconductors only accept currents that are integer multiples of one another. Superfluid helium will spin in a small cup only at certain rotational speeds. These low temperature phenomena vividly demonstrate that the range of the quantum interaction has increased to macroscopic dimensions. This effect can clearly be interpreted as a tendency to merge. The unexpected "cold fusion" reactions may be a result of a fundamental merger of the nuclear forces.

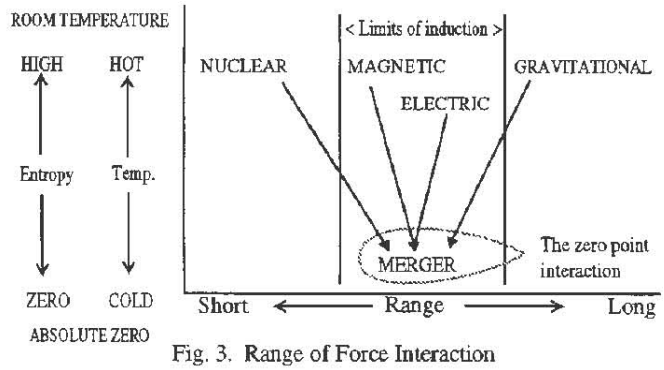


Fig. 3. Range of Force Interaction

GRAVITY

Gravity must exhibit the same general tendencies. The length of the gravitational interaction must decrease in a superconductor or superfluid by the same order of magnitude that the length of the quantum interaction has increased. No induced long range gravitational field, however, has ever been detected emanating from a superfluid or superconductor [4]. Considering the mass to energy ratio and then the ratio of mass to gravity, this is no wonder. The universal gravitational potential is conserved in all mass energy interactions. Any detectable induced gravitational field can only be the result of a tremendous energy flow. Energy flow rates of the required magnitude will never be experimentally produced. An experiment was done at Oxford that can be interpreted to indicate that a far gravitational field has been induced. In this experiment, an apparatus was constructed which allowed superfluid liquid helium to flow through a set of narrow channels from a high to a lower level. It was found that the temperature of the fluid, after passing through the narrow channels, spontaneously decreased. [5] The effect of this cooling is know as the "mechano-caloric effect."

Heat had flowed from cold to hot decreasing the entropy of the liquid helium. The second law of thermodynamics declares that entropy cannot spontaneously decrease. Heat cannot flow from cold to hot. Present theory tries to account for this abnormal behavior by stating that liquid helium is a mixture of two fluids each with a different entropy. These two fluids are separated upon passing through a small orifice. This is know as the "two-fluid model." The two fluid model is flawed in that it is impossible to have two fluids made of a group of indistinguishable atoms. Any theory requiring the separation of two fluids at an orifice is not valid after all of the fluid has passed through the orifice. A correct accounting of the missing entropy can be had by taking into account the gravitational interaction. The decrease of the entropy of the out flowing fluid is balanced by the induction of a positive gravitational field. This field goes on to produce an irreversible expansion of the universe.

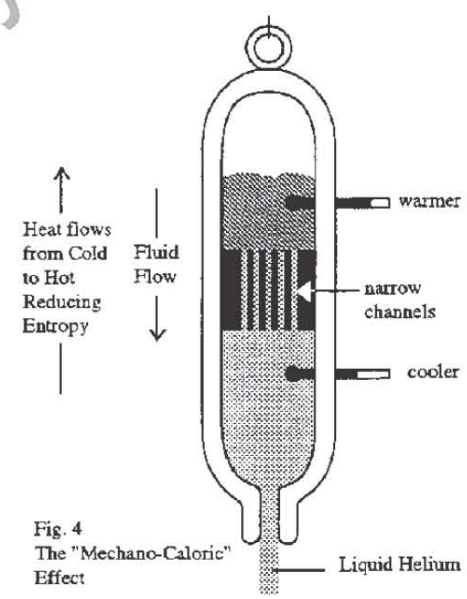


Fig. 4
The "Mechano-Caloric" Effect

CONCLUSION

The relationship between the forces changes in a zero point system. This change involves the defining property of a zero point system, *its angular momentum*. The angular momentum contained within a zero point system is fixed. This momentum must be an integer multiple of Planck's constant "h." Angular momentum is transferred within a zero point system by vibrations know as a phonons. The transfer of angular momentum allows a spin one photon and a spin two gravition to be simultaneously emitted. The emission of gravitons allows genesis to occur. This transfer of angular momentum extends to the nuclear forces. This transfer of angular momentum permits unexpected nuclear reactions to take place.

An understanding of the zero point interaction has been delayed for many years by improper thought. In fact, the technology needed to exploit the zero point relationship has been around for many years. The induction of a gravitational field at low temperatures was demonstrated in the 1930's, however, this author is the first to correctly identify the result. Nuclear reactions have also been discovered in zero point systems. Now that the zero point interaction is understood on a theoretical basis, gravitational and nuclear technologies can be developed. This development will be of great economic and social importance [6].

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Serial # 06/824,530; Filing Date 01/31/86
Examiner, D. Rebsch; Art Unit 212

STUDENT PAPER

THE FUTURE OF ROCKETRY

Taylor Hartley
January 6, 1996

INTRODUCTION

Rocketry, as we know it, could very easily become nonexistent within the next fifty to one hundred years. Today, most rockets are powered by strong chemical reactions. Some people have speculated about using nuclear fission as the propulsion for rockets that will be sent to Mars, instead. In this way the rockets would get there much more rapidly as compared to the conventional processes currently in use. But if speed is of such importance, why isn't atomic fusion strongly considered over nuclear fission? It would produce hundreds, if not thousands, of times more energy than a fission reaction would, thus making it possible for greater velocities. Therefore, if the technology of hot nuclear fusion were properly developed, then this form of propulsion would be much more effective than the already intense process of splitting large nuclei. But from recent discoveries, it is evident that future rockets may not require *any* form of combustion, nor any chemicals or elements as fuel. These recent advances may even yield more power than even nuclear fusion. This ideal form of energy is astonishing because all that is essentially required are magnets; magnets used in such a way as to properly manipulate the zero-point-energy (ZPE) of space, that is, more so than they already do.

THE HISTORY OF AN "AETHER"

In the late 1600's physicists believed that light traveled in waves. But they couldn't explain how light traveled without a medium to move through. As a result, they assumed the idea that a "luminiferous aether" was omnipresent; a substance in space that differed from all other matter. They believed that this aether was present in vacuums, and in all matter, and that it couldn't be seen, felt or weighed [1]. Then in the late 1800's and early 1900's many scientists attempted to prove the existence or nonexistence of an aether. After these experiments were conducted they resolved that there was no such entity as a "luminiferous aether" of any sort because their results didn't indicate otherwise.

IS THE IDEA OF AN "AETHER" REALLY INCORRECT?

Most people today still believe that empty space is a complete void where no matter or aether is present. This idea, though, is a fallacy according to modern discoveries. The existence of some type of "aether" has been proven by experiments involving magnets. This so-called aether, or zero-point-energy (ZPE), is an energy or substance making up the fabric of space itself. Not only do these discoveries and experiments demonstrate the existence of an aether, but Quantum theory relies upon such an idea. "Quantum theory tells us that empty space is not truly empty, but rather contains an enormous amount of untapped electromagnetic energy known as the zero-point-energy or ZPE. (The adjective 'zero-point' signifies that such energy exists even at a temperature of absolute zero where no thermal effects remain.) Such energy can be traced to radiation from the fluctuating quantum motion of charged particles distributed throughout the universe" [5]. Further, "for those interested in detail, the model proof-of-principle ZPE extraction technique they [can] examine is the Casmir effect. This attractive force, typically between closely-spaced metal of dielectric plates, can be shown to derive from an imbalance in radiation pressure from the background ZPE. Specifically, waveguide cutoff effects reduce the number of modes, and hence the associated radiation pressure, between the plates, with the result that the plates are driven together by the overriding exterior radiation pressure. If unchecked, the plates accelerate toward each other with an inverse fourth law force as additional modes are rejected by the closing geometry. In this process energy conserved as vacuum energy associated with the disappearing modes is converted first into kinetic energy and then into heat as the plates collide [5]. Clearly the existence of ZPE is demonstrated in Quantum theory and in the Casmir effect, along with the new experiments and discoveries yet to be explained.

THE HEINOUS MISCONCEPTION ABOUT THE CREATION OF ELECTRICITY

It is a common fact that electricity can be generated by a conductor cutting or breaking the magnetic lines of force (or visa versa). This is how electricity is produced today. Actually, though, it is not a fact at all that electricity is produced by the cutting or breaking the magnetic lines of force - electrical induction has occurred without them being cut. The renowned physicist Michael Faraday performed an experiment, not widely known, which didn't involve severing the magnetic lines of force, but still produced electricity. "In Article 6 'General Remarks and Illustrations of the Force and Direction of Magneto-Electric Induction,' paragraphs 217 & 218 [of Faraday's book], Faraday questions whether it is necessary for there to be relative motion between the magnet and the conductor to establish induction. According to the principles of electricity and magnetism as taught in high schools and colleges, it is immediately evident that without magnetic lines of force (whatever they are) cutting the conductor, there would be no electrical current produced. Faraday took an ordinary cylinder magnet, cemented on the end a copper disk with insulating paper intervening. He reports, "...the magnet and disk were rotated together and the collectors brought in contact with the rim and hub. The galvanometer needle moved as in former cases, and the direction of the magnet [had] been fixed. Neither was there any apparent difference in the quantity of deflection. Hence, rotating the magnet causes no difference in the results." This basic experimental fact is seldom taught in either high school or college!" [2]. This indicates that even when the conductor moves relative to the magnet, electricity is still created without the severing of magnetic lines, and does so by passing through some mysterious field of energy or force either emanating from the magnet or being modified in some way by the magnet, which effect can only be indirectly detected by this type of experiment. Faraday's results are further explained by the article in the magazine *New Energy News,* stating that "without knowing that an energetic space pervades all space and matter, how would one explain magneto-electric induction? Here is a suggested approach: A magnetic field aligns or modifies space energy such that if a conductor is moved through that modified space energy field, electrical current is caused to flow in the conductor. Note that this explanation says nothing about 'cutting magnetic lines of force.' This explanation implies that regardless of how the space energy is aligned or modified the mere motion or rotation of a conductor, in that modified space energy field, will be sufficient to induce an electric current." Thus we see that electricity is the product of an energy in space being manipulated and utilized, not necessarily by the magnetic lines of force being cut.

PRESENT KNOWLEDGE AND WORK BEING DONE INVOLVING THE AETHER

With Faraday's discovery and the above explanation, an experimentalist named Bruce dePalma developed what is called an N-machine, while working at MIT and afterwards. This N-machine proves the existence of some sort of aether because it generates electricity from an outside force which doesn't involve the cutting of magnetic lines.

Two others, Tewari and Inomata, developed this N-machine further and discovered that "the output power is directly proportional to the strength of the magnetic field, the area of the conductor, and to the rotational velocity of the conducting disk." These N-machines are described further as "electrical generating machines" which are characterized by the following:

1. The demonstrated ability to produce more electrical power than used to rotate the machines.

2. An electrical out put of low voltage but high current.

3. The dynamic characteristic that requires relatively high rotational speeds to produce over-unity power.

4. The apparent lack of increasing counter-torque on the generator shaft as high output is achieved

5. The requirement for relatively high magnetic field strengths (Tewari, 1993 [article within *New Energy News*]).

The N-machine is one example of a device that taps the energy of space for a source of energy. This source of power is explained further by the physicist Harold E. Puthoff. He, along with others, has provided five peer-reviewed articles published in prestigious technical journals which provide a much greater understanding of space energy also called zero-point-energy (ZPE). For example, some of these understandings are:

1. Space energy is everywhere. Therefore, devices that tap space energy can be used everywhere.

2. Materials having ferromagnetic properties locally change the nature of space energy so that the motion of a conductor produces electrical flow.

3. A massive rotating body modifies space energy so that local time is modified as measured by a clock.

4. The proper arrangement of magnets and coils (usually bifilar coils) locally modifies space energy so that gravity is reduced.

5. High intensity electrical fields locally modify space energy so that mechanical forces are produced.

6. The Methernitha rotating power generator does not violate the Law of Conservation of Energy. This machine is a clever method of locally modifying space energy so that electrical power can be produced.

7. N-machines do not violate true physical principles, they merely transform energy from space to electrical energy. Theoretical physicists, such as Puthoff, should now be able to write the equations that explain the operation of N-machines.

8. Over-unity magnetic motors and generators are not perpetual motion machines but they use magnetic fields to store and capture space energy to produce extra power.

9. Atomic and nuclear reactions can be expected to be catalyzed by local modifications to space energy. Specifically, the Coulomb barrier is likely a function of local space energy and is modifiable by subtle means (as contrasted to hydrogen fusion by using the brute force methods of the Tokamak).

10. The transport and the speed of photons (light) is a direct function of the nature of space energy. It is speculated that some of the phenomena that locally modify space energy may modify the speed of light.

11. Inertia is a natural byproduct of space energy, therefore, those devices that modify space energy may modify inertia. We should try to operate a massive fly wheel within a strong magnetic field and measure its inertia. For example, spinning up a massive fly wheel stores space energy which is released when the flywheel is decelerated. If an effect is found that reduces the inertia on spinup then the removal of the effect should provide additional energy on spindown.

12. Flying objects, identified or not, may be equipped with inertialess drives and thereby be able to make sudden changes in direction without violating the laws of physics.

13. NASA can finally achieve methods (at least theoretically) of moving large payloads into orbit without "mass throwers." Rocket propulsion for spacecraft is the most inefficient means of propulsion currently used by mankind and *its days old use are numbered* (italics added).

14. Anti-gravity, levitation, and inertialess drives await our improved understanding of the means by which space energy can be modified [5].

THE POTENTIAL OF AN "AETHER"

With this understanding that tapping space energy creates more energy than required to tap it, can reduce gravity, change time, modify the speed of light, manipulate inertia, and cause levitation, one can easily imagine the potential. This potential is even greater when the amount of energy in space is considered. "Scientists have calculated that the amount of energy in each cubic inch (or cubic centimeter) of space is more than one would obtain if he/she were to change 10^{90} grams of matter into energy according to Einstein's formula ($E = mc^2$). That enormous amount of energy is so unbelievably large that if you could convert one cubic inch of space to practical energy use, you could furnish all of the energy needs of the earth for several years!" [3]. By using devices that utilize the full potential of space energy, a form of propulsion will likely be invented which replaces the forms we currently use with one that is prodigiously more energetic and practical.

HOW AN AETHER RELATES TO ROCKETRY

In talking with Hal Fox [4] about the devices that have been manipulating space energy, he told me about the Searl-Effect Generator which rotates cylindrical magnets inside magnetic rings. Searl was testing this device in his kitchen. When he turned his machine on, bolts of electricity discharged across the surface, and it then began to levitate until it crashed into his kitchen ceiling and ruined it. He then decided to test it in his backyard. The same effects were observed, but this time his machine continued to rise into the atmosphere with nothing stopping it. He still believes his machine is floating somewhere in space. The significance of the implications his experiment demonstrated are very profound because they mean that by using the magnets in relatively the same way he did, a propulsion unit can be constructed which manipulates space energy in the same way in order to soar through the immensity of space without any form of combustion. And because of the availability of space energy and its amount of power that can be utilized from space everywhere, these space energy manipulating engines could travel to anyplace in the universe without carrying fuel, and at tremendous speeds. After much development, inertia could be eliminated, or rather, seem to be eliminated, where necessary, and perhaps the speed of light exceeded; time would no longer be a problem in long distance space travel, either, because of the magnificent speeds attainable and from the modification of time. And at the same time, more energy could be produced than required for the engines to continue working. **Thus, the future of space travel could be quite different than what it is now if these discoveries are pursued.**

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LETTERS TO THE EDITOR

THE RELATIVE IMPACT OF THERMAL STRATIFICATION OF THE AIR SURROUNDING A CALORIMETER

Mitchell R. Swartz[1]

Last month there were several responses to the paper entitled "Potential for Positional Variation in Flow Calorimetric Systems" which discussed a theoretical examination [1] of heat and mass flow [2] with inclusion of the Bernard instability [3].

"I've been thinking about another problem that could be plaguing the Cravens-style vertical flow calorimetry ... thermal stratification in the air space outside the cell. In at least one of the public demos Cravens put on, he enclosed the cell in an insulated chamber made with two Dewars placed mouth-to-mouth. This created a more-or-less dead airspace around the cell and, since the cell was operated at a temperature significantly above ambient, I would expect a considerable temperature gradient to exist in this air space, hottest at the top and cool at the bottom. With the very slow flows he used (14 ml/min is ~0.7cm/sec flow velocity in 1/4" ID tubing), the temperature sensors could be significantly affected by simple conduction through the walls of his fittings. Such a problem would cause the upper temp sensor, which is the outlet sensor, to be hotter than the lower sensor ... resulting in a false positive indication. Because the airspace stratification is "driven" by the heat of the cell, this false positive indication should become larger when the cell temperature is raised...."

[Scott Little (little@eden.com)]

Several issues appear to be involved.
1) Could thermal stratification of the air physically located outside of the electrolytic cell influence the thermal leakage from the cell by changes in the net thermal conductance?
2) Does thermal conduction through mechanical fittings effect the reading of a temperature sensor?
3) Could such a thermal air thermal stratification effect also alter the temperature sensors through the fitting effect (described at #2)?

The following is the semiquantitative estimate of the impact of the phenomenon discussed in question #1. Instead of a simple mean temperature of outside air of 30°C, in this gendanken experiment assume the air is varied over the temperature range from 20 to 40°Centigrade. Assume there does not exist any variation in the air or calorimeter conditions with respect to time or external mass transport. The enthalpic losses to the local "ambient" environment from the cell include conduction, radiation (with the 4th power temperature term in the Stefan-Boltzmann equation), and convection losses of two types — both flow incurred and thermal induced [4,5]. To qualitatively determine the impact, let us model the calorimeter in a single dimension and as a linear system. We will ignore for simplicity spatial- or time-variation of the material factors, boundary effects [6], and other isothermal effects.

Changing the air by thermal stratification probably would mainly alter the thermal conduction term. That thermal conduction loss is in "series" with the thermal conduction term through the calorimeter wall itself. The thermal conductance of the two compartments — consisting of the air and the outer wall of the calorimeter — could be modeled as

$$K_{equiv} = \frac{K_{wall} * K_{air}}{K_{wall} + K_{air}} \quad [\text{ cal/(sec-cm}^2\text{)(degC/cm) }].$$

The equation is derived similar to the corresponding electrical system with the thermal resistances added in series, after converting the thermal barriers (resistances such as R_{wall}) to thermal conductance ($R_{wall} = 1/K_{wall}$).

How much could such thermal stratification — physically located outside of the electrolytic cell — influence the net thermal conductance loss of the calorimeter and thus alter the measured result of a calorimeter? These thermal

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conduction changes are based upon relatively small differences in thermal conductivity of the gases surrounding the calorimeter. The thermal conductivity of air varies from 42 to 45 cal/(sec-cm^2)(degC/cm) x 10^{-6} between 20 and 40°C. In this example, this difference in thermal conductivity amounts to a 6% change, ± 3% around the mean. Furthermore, the variation's impact might, if it varies linearly with temperature, just balance when integrated over the entire wall. The impact, based upon convention models of heat and mass transfer [4,5,6], is that if the spatial distribution of temperature is even and linearly distributed, there will be no significant changes upon calorimeter calibration. It appears that only when there is a nonlinear variation of the air's thermal conductance-temperature curve, that there accrues significant deviation from the calibration. To calculate the impact of the effect, let us assume the nonlinear asymmetry is quite significant and results in a 2% variation. With equation (1), it is possible to actually substitute number. If K_{air} is a tenth that of the wall, $K_{air} = 0.1\ K_{wall}$, then a hypothetical 2% asymmetric stratification change in air conductivity will alter the total conductivity by about ± 1.8%. If K_{air} is ~K_{wall} (10 K_{wall}), a hypothetical 2% asymmetric stratification change in air conductivity will alter the total conductivity by about ± 1.0% (± 0.2% respectively).

Most importantly, as shown in Fig. 1, the thermal conductivity effects generated by the stratification are quantitatively small, compared to the impact of the "hydrogen gas displacement effect" which might exist in some electrolysis systems. So what is the impact of possible thermal stratification of gas external to a calorimeter? The overall impact of such a distribution upon the overall system thermal conductance is small. This is reasonable because it must be less than a few % change from expected, and furthermore — only those changes deviating from linearity will produce a net change. Finally, any putative change from such thermal stratification is insignificant compared to the "hydrogen gas airspace effect" which occurs when the air around the electrochemical cell is replaced by hydrogen (or deuterium in heavy water experiments) which thereby markedly increase the thermal conductance of the system (Fig. 1). Most significantly, the hydrogen gas effect has the impact of making calculations of putative excess energy a lower limit to that which may have actually occurred if such systems have such an unanticipated hydrogen volume in the gas space.

In summary, temperature gradients in the vicinal air surrounding a calorimeter can exist for several reasons. For this to be significant there must be either a nonlinear or an asymmetric thermal air stratification. Even then the impact is small and probably not significant when compared to the quantitatively larger hydrogen gas airspace effect.

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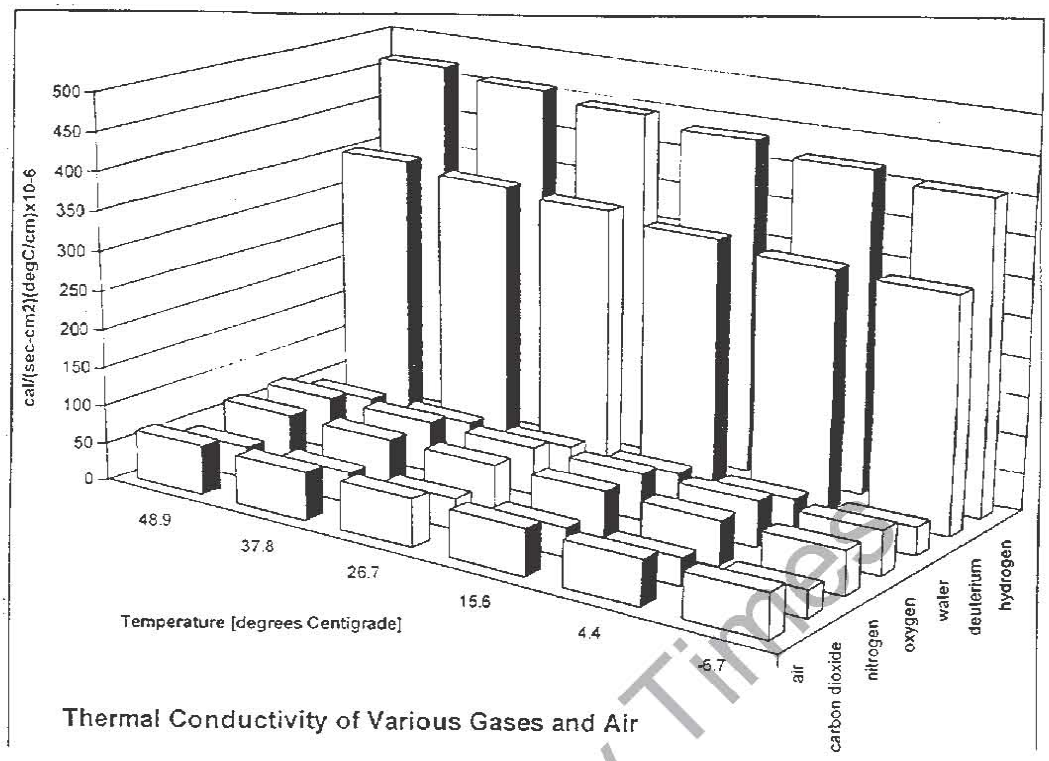


Temp. (C)	air	carbon dioxide	nitrogen	oxygen	water	deuterium
-6.7	56.2	33.7	56.2	57.2	36.8	305.8
4.4	58.3	35.6	58.3	59.4	38.9	310
15.6	60.3	37.6	60.3	61.6	40.5	322.3
26.7	62.2	39.7	62.4	63.6	42.6	334.7
37.8	64.2	41.7	64.1	65.9	44.6	343
48.9	66	43.8	65.7	68.2	46.7	355.4

Fig. 1 — Thermal Conductivity of Gases
The hydrogen isotopes show markedly greater thermal conductivity than other, higher molecular weight, gases. This 3D bar graph demonstrates thermal conductivity (cal/(sec-cm^2)(degC/cm) x 10^{-6} as a function of temperature (-7 to 49 degrees Centigrade) for air, carbon dioxide, deuterium (D_2), hydrogen (H_2), nitrogen (N_2), oxygen (O_2), and water (data after Handbook of Chemistry and Physics (Chemical Rubber Co., 1973).

A LETTER ABOUT NICOLAE VASILESCU KARPEN

from Camil Alexandrescu

As I promised you many "letters" ago, I am now beginning to tell you about Nicolae Vasilescu Karpen and his strange electrical cells. My investigation on this matter is not finished yet, however, I have an important amount of information that is quite ready to be shared with you.

PART I

Nicolae Vasilescu Karpen was born in the Romanian city of Craiova, in 1870. First, he pursued his university studies at the "National School of Roads and Bridges" in Bucharest and became an ordinary engineer in the field of highway and railway construction. He studied the engineering just a short time, as he felt attracted by the electricity and its applications (very new and impressive in that age, we must remember), he left the country for Paris. Here, Dr. Karpen graduated from both "L'Ecole Superieur d'Electricite" and the Science Department of the University of Paris, in 1902 (attending them simultaneously). His first important scientific result is offered to us by his doctoral dissertation, in 1904: "The Conclusive Proof for the Rowland's Effect," very uncertain and disputed at that time. The proof consists of experimental evidences and the adequate theoretical considerations, associated with them. Remember, the Rowland's Effect means that the electrically-charged bodies which move uniformly, generate a magnetic field being entirely equivalent to a conduction-current magnetic field, and the corresponding quantitative laws.

Dr. Karpen did not stay in France too long, he came back to Romania in 1905, where he started a huge scientific and professorial activity. Most important, he was the main founder of the Polytechnical University in Bucharest in 1920, and its first rector (chancellor). Of course, he dealt not only with electromagnetism (EM), but within the EM, he received a long series of original results, scientifically and technically momentous, at least, for Romania of those times. I do not give examples of them here, it is really important that favorite concern of Dr. Karpen became electrochemistry (after 1920).

Dr. Karpen was among the first men of science who rejected the concept of **magnetic mass** and substantiated the EM theory without it. At the same time, he was initially an enthusiastic supporter of the second principle of thermodynamics and (according to some texts about him, it seems to be quite so!) and became a world-recognized authority in the domain of the second principle. He delivered lectures on the second principle (with experimental demonstrations in front of the audience) at French Academy, where he was invited many times.

But, little by little, a dramatic turning occurred, the evolution of his thorough electrochemical research, full of unexpected laboratory results, compelled him to change his opinions, to be against the second principle and against the renowned theory of Walter Nernst. Dr. Karpen admitted the existence of free electrons in liquids, and especially in electrolytes, since 1923 (maybe the first to do so!). Such a hypothesis was judged to be **absurd** in those years, but nowadays, it is experimentally proven, of course, within other context (1943: the fast photospectrometry; 1950: the radiochemistry).

Applying the new facts and concepts he embraced, Dr. Karpen created a little **toy**, a real **perpetuum mobile device of the second type**, as it is said. So, in 1926 (remember this year, almost 70 years ago!) he dared present his new **toy** to a large audience at the French Academy. The toy was a simple pair of the so-called **concentration cells** (or **piles**) powering a tiny rotational motor. Each cell was a closed glass vessel having two (different) gold electrodes and filled with sulfuric acid. The surfaces of the electrodes were adequately processed by specific mechanical and electromechanical procedures. Dr. Karpen claimed that the electrodes will never be sulphated and the sulfuric acid will never be spent. The motor will be continuously powered by the two cells and its motion will be everlasting. The cells will run without any second source of heat (the **cold** source), just from a single source of heat (the **hot** source) that is merely the environment.

Immediately, the Romanian professor lost his respectability. He was asked, sarcastically, "Could you at least get into motion an elevator or a small car?" Of course, he couldn't. The power of his demonstration toy was just several watts and nothing more. The scientific public and also the common public refused stubbornly to take into

consideration any possibility of truth in Dr. Karpen's claims. And his lecture was soon forgotten by everyone and his papers and books are almost never read in western countries. However, here in Romania, Dr. Karpen kept his reputation as a scientist, though his perpetuum mobile was also neglected or rejected and forgotten.

The first concentration cell device would have been made by Karpen in 1923 (remember again the year — almost 73 years ago! It is the year of his new electronic hypothesis). Professor Karpen had waited three years before he revealed his electrical perpetuum mobile to the scientific community, being completely aware of all his professional duties and involvements. It is said that the Karpen device ran continuously (in France and in Romania) until the 1960's, unnoticed by the most scientists and not understood by the inquisitive onlookers (the "profanes").

A perpetuum mobile (the same device or another copy?) was displayed just in the upstairs lobby of the Romanian Academy Library in Bucharest, a place well-illuminated and much frequented by many people, having the known fate, unnoticed, not understood by all of the onlookers of any profession.

Prof. Karpen became a fellow of the Romanian Academy in 1922. In 1940, he retired from the Technical University (age 70), but he kept on with his scientific work. In 1946, the communist leaders expelled him from the Academy, using their **standard stratagem**. They turned the normal Romanian Academy into the "Academy of the Popular Republic of Romania," controlled by communists and formed only from "politically sound personalities, well-devoted to the laboring people and to the Party ..." Nevertheless, he was brought back to the new Academy in 1955, when the Stalinist tempest became (a little) milder. How weathercock harlot the policy is!

Meanwhile, Dr. Karpen was appointed as researcher in the (newly modified) Physics Institute of Bucharest, where he worked fruitfully (between 1950-1955), despite his age. After his death in 1957 (in Bucharest) all the perpetuum mobile device(s) were shifted to the Technical Museum. Here it (they) ran later on, maybe even for another decade, then it (they) disappeared without any trace.

The story is just a story. I do not know exactly how long this device (these two devices) ran effectively. The span is between thirty and sixty years.

PART II

The story came to my ears in 1976, quite immediately I was aware of the importance of the problem behind it. Notwithstanding this, my attitude was then a mixture of "waiting, pondering" and passivity. I have always been much interested in (theoretical) thermodynamics, but not so much in electrochemistry (like Dr. Peter Glück, whom I met many years later). Almost twenty years passed as a fast dream-filled flight, and all this time I laid aside the subject of the Karpen's cells and the related matters. Till late this summer, I was prevented from tackling their problems, mainly by the vicissitudes of my personal life and less by my professional orientation and early options. And now? Yet, I cannot deal with them quite professionally, at least for the time being. My choice in activity is already done in the fields of physics. But I think the view of the general fields of physics is necessary and promising, besides the obviously needed views of thermodynamics and specific electrochemistry.

I have set out an investigation about the Karpen **toy(s)**, like an inquiring agent in movies. The essence of this investigation is to search for them step by step, patiently, just in Bucharest. Going on the trail of the life and work and results of the master. But the circumstances are not favorable to me, now. I was forced to postpone my journey to Bucharest many times this summer. All these undesireable postponings are the reason I am writing this letter so late, and before I go to Bucharest.

Meanwhile, I continued my inquisitive **trips** to the libraries of my old town. Searching for more (pre-selected) subjects. Thus, I discovered many of Dr. Karpen's published works, both in Romania and France. Among them, a certain book entitled "New Phenomena and Theories in Electrochemistry and Chemical Physics" (NPh) which appeared in 1957. The book was printed through the office of the Romanian Academy. It is an isolated edition, written, of course, in Romanian. At least for the time being, this book is the single direct source about the **perpetuum-mobile** that is available in my town. In this book, Dr. Karpen is outspoken that the apparatus he created in order to prove the reality of the physical processes not under the second law of thermodynamics, is a genuine perpetuum-mobile of the second kind. Under his influence, I had already used this phrase in my letter-text, deliberately. (See further description.)

The other Karpen writings I found deal only with different scientific matters. They are most interesting and full of surprises, but not with dynamical apparatus. According to all these works I have read, the legend about Dr. Karpen's wonderful toy(s), seems to be only partial, while the whole biographical information is right. Especially the age of the apparatus seems to be unconfirmed, as the author says that he began to improve his cells (of type called K), in order to make the everlasting running motor, around early 1955. Moreover, he refers to a unique motor he made effectively. Hence, the toy appears as being much younger. Nothing is said about the monitored span of time, during which the apparatus ran indeed. Nevertheless, the legend-like story is a problem, and not a simple one. The book was issued during a hard Stalinistic period, when just to tell friends about a work carried out, or at least started abroad, **along with capitalists**, would have been dangerous. By that time, each text published had been checked over thoroughly (and especially "ideologically"), and cut out or modified in order to be politically correct (as if the author would have been most devoted to the laboring people and to the "Party"). The book itself raises many disquieting questions whose answers, I expect, will be found by a future inquiring struggle.

PART III

In his book, Prof. Karpen treats minutely his theory on free electrons in liquids versus Nernst's theory, and theorizes many types of electrical cells, along with plenty of experimental data, both picked up from literature and obtained by the author himself in his laboratory. The notion is introduced of compensated diffusion (of electrons, ions etc.) as a fundamental process at the interface of two different and non-mixable media, and standing apart from the second law of thermodynamics, like the brownian motion. As I understand, the phrase of **compensated diffusion** belongs to Dr. Karpen himself. The types of electrical cells he approaches here, are:

a) Various chemical cells (as classical: Daniel, Volta, Grove, Leclanche, etc.) having chemically stable or non-stable electrodes.

b) The cells which harness the Volta-effect between joined different metals, and especially the peculiar variant called **the cell with vacuum** as I understand, the contriving and the phrase belong to Dr. Karpen, too.

c) The concentration-cells, having, as a rule, chemically stable electrodes. The term "concentration" refers to the presence of various ions in electrolytes (i.e., I^- from I_2, Cl^- from Cl_2, H^+ from H_2, O^{--} from O_2 or those from acids, and so on, in a definite and adequate concentration).

d) The cells of type K (as named by Dr. Karpen), the K-cells are a particular class of concentration cells, which are thermodynamically reversible and whose electrolyte may be pure liquids as the distilled water or pure acids, as well as standard solutions of acids.

The design of a K-cell

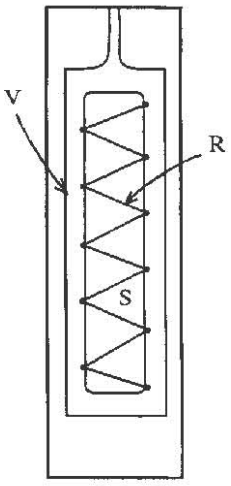


Fig. 1

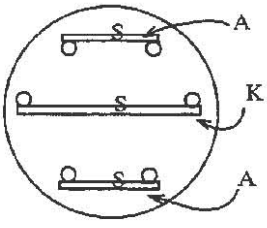


Fig 2

It is most important, the author states clearly that these cells, here listed at b, c, d are liable to "**absorb**" energy from the environmental heat and to turn it into electric energy, via some complex processes whose core is the compensated diffusion. The "**absorption**" of energy from environment is intimately connected with the thermodynamic reversibility, in Dr. Karpen's view.

The K-cells used for the ever-playing motor were concentration cells with oxygen. Here is a brief description of those K-cells (see Figs. 1 and 2).

The vessel of the cell is a glass tube 25 cm long and 7 cm diameter, tightly closed (V). The positive electrode is made from platinum coated gold, in such a manner that its surface is highly "**spongy**" (this porosity is essential). The negative electrode is made from gold only and has a compact and very smooth surface (its "**gloss**" feature is also essential). The positive electrode is called "cathode" (K) and the negative electrode is called "anode" (A), that is quite inverse than usually (in electrotechnics, etc). In order to have a large surface, the electrodes are made as long ribbons (R) (2 m long), their

cross section is rectangular (2 mm wide and 0.04 mm thick). Inside the vessel, there are three distinct ribbons, all wound on glass plates of rectangular shape as supports (S). The middle ribbon is the cathode K, while the two side ribbons are the same anode (A). The electrolyte is pure sulfuric acid, that does not "**assdil**" the material from which the electrodes are made, as a matter of fact, Dr. Karpen has chosen for his electrodes such materials as gold, platinum, iridium, graphite, just because of their chemical stability with respect to acids or other corrosive electrolytes. That is the set-up!

When the circuit is open, the electromotive force (tension) is 0.35 Volts. After the circuit is closed upon a resistor, the electromotive force decreases gradually, tending to zero. But, when the circuit is opened again, the electromotive force begins immediately to increase to the same level of 0.35 Volts. The expense shows that the increase lasts longer than the decrease. No chemical reactions, no physical change! A ceaseless succession of periods of "**opening-closing**" of the circuit enables the cell to provide an amount of electricity "**infinitely large**," of course in an infinite span of time, as the author himself said. The perfect physical reversibility (in Karpen's language), without any chemical alteration of the electrolyte or electrodes, that is always found experimentally, suggests that the electrical energy is obtained merely from the internal thermal energy of the cell itself, whose temperature decreases effectively, even if very little! There must be a thermal energy transfer from the environment to the cell, through its walls, so it may say that the K-cell accomplishes the "**tapping**" of environmental energy in the most direct manner, and using the environment as a single source of heat.

Now, what are the intimate processes that could explain the production of electrical energy? I present briefly here Dr. Karpen's theory:

The electrolyte contains dissolved oxygen (remember, the K-cells are **concentration cells with oxygen**) which is adsorbed by the surfaces of the electrodes, but in different amounts. The cathode, whose surface is **spongy**, retains much more oxygen ions O^- than the anode, whose surface is "**gloss**." Consequently, the concentration of electrons on the cathode surface is significantly lower than the concentration of electrons on the anode surface. That is according to the law of mass action in physical chemistry. So, a potential difference appears. When the circuit is closed upon an external resistor, the normal "**diffusion**" of electrons through that external resistor is felt as the electric current. While the charge of the anode decreases and the charge of the cathode increases toward the electrical equilibrium, an electric field is present inside the electrolyte as oriented from anode to cathode. Accordingly, the anions of oxygen leave the cathode for the anode as tending to the concentration equilibrium. So, the electromotive force decreases toward the zero value. After the circuit is opened again, all these diffusion processes recommence in the opposite direction, that is the initial direction. The reversion of the diffusion processes results from the local interface processes, whose pattern is the "**compensated diffusion**" between the solid matter of the electrodes and the liquid matter of the electrolyte, against the second law. The author describes them in detail. The compensated diffusion is a sui-generis multiple kinetic equilibrium between the various fluxes in both directions with respect to the surface, an equilibrium based on the well ordered (not random!) motions of neutral and charged particles (electrons, ionized atoms and molecules, etc.) in a permanent spontaneously issued kinetic circuit along with the dissociation and association of the particles involved in this kinetic circuit.

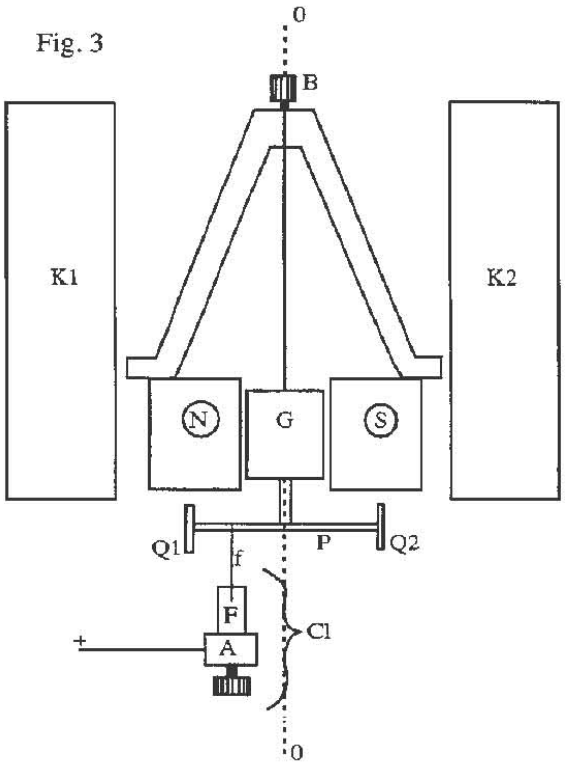
An interesting observation of the author, in the context of the K-cells, the diffusion of electrons from the **"higher concentration (potential)" to the "lower concentration (potential)"** through the external circuit (resistor), resembles the expansion of gases from a higher pressure to a lower pressure accompanied by a heat absorption. When the expansion is adiabatic, the gas temperature decreases, as is well known. But this particular case is not proper here, the expansion is thought to be without any thermal isolation, like the diffusion. Such a resemblance reveals the physical nature of the K-cells, macroscopically speaking and gives (technical) suggestions for the future.

PART IV

The **ever-playing toy** described by Dr. Karpen was indeed a tiny laboratory oscillating motor, obtained from a simple electromagnetic galvanometer, adequately modified. (See Figs. 3 and 4) Two K-cells (K1 and K2) were used simultaneously in order to provide for the necessary power. They were connected to the central coil (G) of the moving frame, not directly, but by means of the contacting device C.

The moving frame is suspended by a long and thin wire H of brass/bronze (0.08 mm diameter), that is fastened to the iron carcass of the apparatus by means of the little screw device B, in order to adjust the vertical position of the frame. The frame is placed between the two poles of the permanent magnet of the modified galvanometer. The field induction is about 800 Gs.

Fig. 3



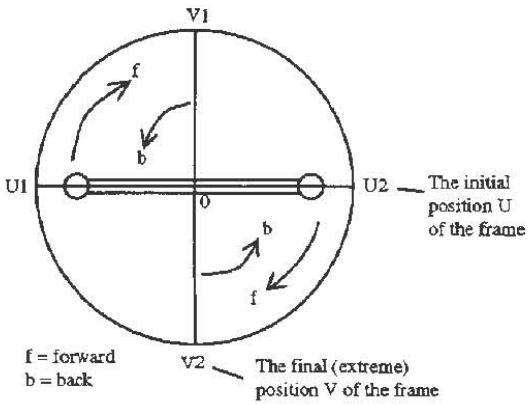


Fig. 4. The geometry of every cycle.

A horizontal rod P is rigidly fastened to the frame. It has two little weights Q_1 and Q_2 at its ends, to increase the angular momentum of the whole moving system. The rod is endowed with a highly flexible wire f as a conductor. The horizontal rod is 7 cm long and weighs about 3 g. each.

The conductor f is a very thin wire (0.02 mm diameter, and 15 mm long). It can touch the conductor F. The conductor F is a thicker stiff wire and its position may be preset and adjusted by means of another screw device, A.

The conductor f moves along with the rod P and touches periodically the conductor F, thus enabling the circuit to be closed upon the coil G, and to be powered by the cells K1 and K2 connected in series.

Each touch (in position U) determines a current pulse through the coil G and therefore, a mechanical couple which rotates the frame G and its underlying weighted rod Q_1PQ_2. As this system GQ_1PQ_2 turns, the touch between f and F stops immediately. The turning motion continues inertialy, until the system attains the extreme position V and where, the elastic-torque of the suspended wire H determines the motion in the opposite direction. The system turns back and when it attains the position U again, a new fast touch enables a new electrical pulse and therefore a new mechanical couple, and so on. Thus, the oscillating motion of the system GQ_1PQ_2, that expresses the yielding of electricity from the two K-cells, is a quarterly torsional oscillating motion, as shown in Fig. 4. The duration of the touch is about 0.5 sec and the duration of the passive oscillation is about 18 sec., the angular velocity being about 0.28 rad/sec., as designed by Dr. Karpen.

During the touch (the **active** phase of the oscillation) the cells discharge, their electromotive force decreasing, during the rest of the cycle (the **passive** phase of the oscillation) the cells charge again, their electromotive force reincreasing spontaneously. In essence, this apparatus is just a mechanical commutating device whose functional motion is kept up with the energy delivered by the cells "from time to time" and "binding" the short discharging active phases and the long charging passive phases, together in a continuous display of alternations. The apparatus can run permanently in any conditions of temperature and luminosity, as its maker claims, no matter if it is a bright day or a pitch dark night, no matter if it is a hot summer or a frosty winter.

Dr. Karpen states that his apparatus ran effectively in his laboratory, but he does not say how long. He states about the independence of running with respect to the environmental parameters, but he says nothing about frequency or angular velocity measurements to be correlated to these parameters, and even less about the inner electrolyte temperature measurements to be plotted as a time function, and so on. But the legend was woven, and it must be cleared up in all its intricate threads.

And now, some comments of mine:

1. There are many formulations of the second law of thermodynamics. In all university text handbooks, it is said that the different formulations of the second law are logically equivalent. Is it indeed so? As a principle, the strict equivalence proved, according to the formal logic, does not guarantee a strict equivalence in physical content(s), because of the presence in demonstrations of some unavoidable definitions and considerations that carry implicit (I would say, "masked" or even "hidden") additional physical content(s), despite its (their) appearance of pure mathematical concepts or logical conventions. In this letter, I can not speak in details about such a matter, but, in my opinion, the justifiability and the correctness of any denial pointed to the second law of thermodynamics is relative to the regarded formulation (enunciation). So, I am asking, was the formulation of the second law denied by Dr. Karpen the most general one (that is, the most comprising in "physical substance")? I think not. In his book, Dr. Karpen refers to the Carnot and Clausius enunciations that are, on the contrary, the most intuitive and simple formulations and therefore, not the "strongest," according to the above statements. Especially, the notion of "source of heat," originates in technics and it is most concrete and particular. So, Dr. Karpen is against a "**weak**" formulation of the second law, and he is not aware of this fact.

2. Dr. Karpen does not distinguish between the "**inversability**" of a thermodynamical process and its eventual "**reversibility**." He uses the word reversibility, always. But he is not the only smart man who is, however, confused by these two words that have the same meaning in common language and are bad and confusingly explained as physical terms in so many books on thermodynamics.

The inversability of any physical process simply means that its **going on forward** may be changed in the going on backward, by an adequate action/intervention. This is without regard to the way(s) of the process between its extreme physical states, going either forward or backward, all the states being designated in a proper formal state space. The reversibility especially means that the two ways of the process, forward and backward in the state space are identical, of course, for the process of a closed system. This ideal concept can easily be understood when the process is conceived as being **quasi-static** (equilibrium-like) and hence its (Intermediary) states may be represented as points in the formal state space, while it can be more difficult to understand when the process is deemed as being an arbitrary (non-static) one, and hence its instantaneous states have to be described in terms of (scalar, vectorial, etc.) fields. Many books on thermodynamics identify the two notions, reversibility and **quasi-static**, and this is the second logically wrong indistinctness.

Dr. Karpen found the lack of chemical or physical alterations at the end of every cycle during the run of his apparatus and he named it "reversibility." But, the cycles of the cells are formed by two distinct phases ("charging" and "discharging", as I had already said) that have straightforward very different durations, being opposite ways between the same extreme states. Hence, their own displays of physical intermediary states of the electrolyte and electrodes are quite different. According to the above definitions, this is not a genuine "thermodynamical reversibility," it is just an irreversible inversability that is possible because the cells are (thermodynamically and electrically) open systems (but not only because of the "opening," -- see the next item).

3. The periodicity appears as an essential feature. As a matter of fact, the **secret** of the everlasting motion lies in the structure of the apparatus, in a double meaning, the **structure** as a technical set up "in complexity" and the **structure** as the underlying process pattern, characterized by coupled gradients in a periodical variation. The Dr. Karpen's apparatus is a **perpetuum mobile**, indeed, but not against the second law of thermodynamics in its largest meaning. The apparatus is a **perpetuum mobile** because it harnesses the second law, as a "horse" inside a complex structured (technical) system; that feat is more than a simply deemed open system. Here's a matter to be pondered!

The theoretical deficiencies I am now pointing out do not diminish the merits bestowable to Dr. Karpen. How difficult and fortuitous, the "**tapping**" of natural laws and ingenious ideas, especially in order to find unconventional means for the tapping of outer diffused energy!.

4. This Dr. Karpen's apparatus resembles those presented by Dr. N.E. Zaev from Moscow in his paper "The Close Prospective of Future Energetics" (*Fusion Facts*, vol 6, no 9 (March 1995), pp 18-21 or *NEN*, vol 2, no 11 (Sept, 1995), pp 2, 3). In spite of some nuances and even differences in language, he says the same thing on the perpetuum mobiles as energy tapping devices. I was pleasantly surprised when I read his paper a few days ago, just before I began to write this letter. It is remarkable the structural resemblance to the old Chinese "**bowing bird toy**," that his paper suggested to me.

5. Such resemblances and even identities among "**perpetuum process**" devices/apparatus/machines, reported in most different and remote places in the world, in (presumably) any historical age, seem to be scientifically significant

and meaningful, as much as is allowed by the uncertainty of the available sources and by the strange, unexpected features assigned to those machines, devices etc. I think, Dr. Karpen's cells can not be an isolated contrivance, geographically and historically. They belong to a general historical trend throughout the world, exhibiting miscellaneous laboratory or applied or home exotic contrivances and indicating a few main and definite directions, the systems functioning by the (marked or covered/hidden) tapping of the diffused environmental energy, constitute one of these direction.

6. Could one find some relations between Dr. Karpen's electrical cells and today's cold fusion electrochemical cells? Most probably not, they appear as being different physical phenomena. However, the very intimate interface processes of the two phenomenal categories are still far away from a complete and sound understanding.

7. Could one find some relations between the tapping of (thermal or non-thermal) energy from the surrounding matter and the tapping of the **deep** energy of the quantum vacuum? Perhaps, at least, some formal (mathematical) analogies? If not some common physical features or even physical interferences?

I think these two last items are questions to be pondered and not discarded. The future will undoubtedly offer the answers.

Sending you my best regards,
Yours faithfully, Camil Alexandrescu

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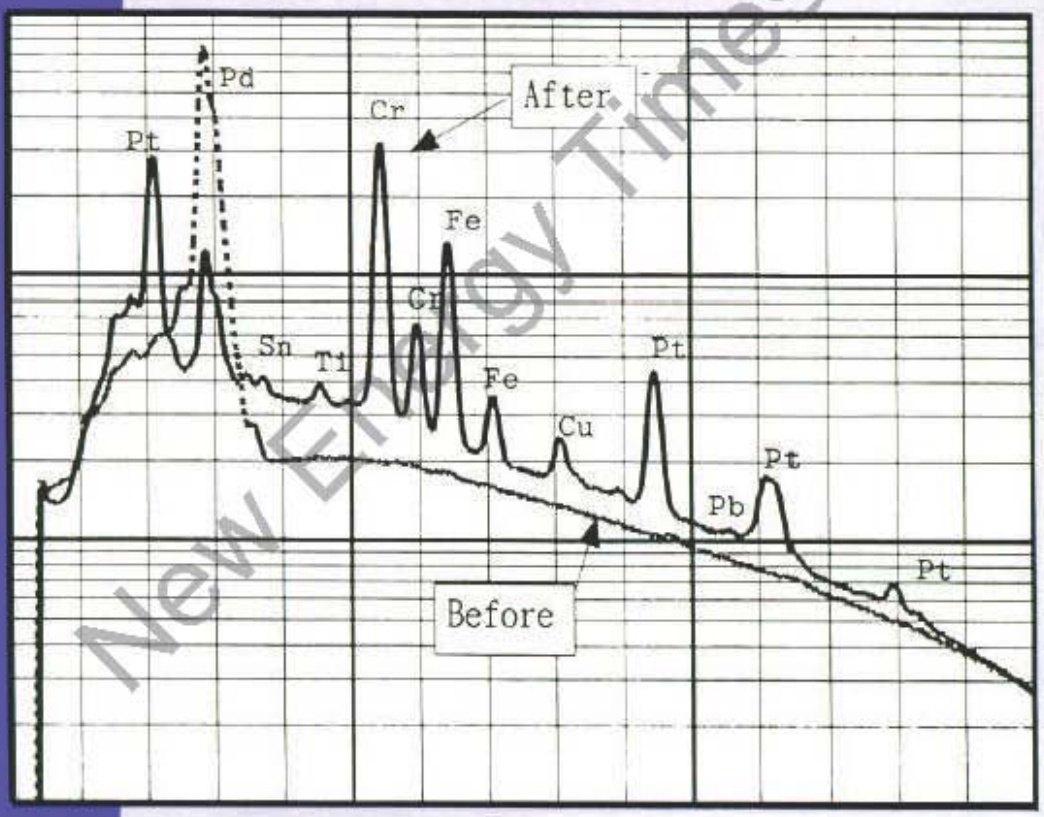

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NEXT... **The Autumn Issue of JNE will contain the proceedings of the second conference on Low-Energy Nuclear Reactions to be held September 13-14, 1996.**

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ERRATA

Journal of New Energy, volume 1, number 2

p. 28: under heading "Discussion About the Concept and Experiment," on the first line, last word should be **field**, i.e., torsional field generator.

p. 29: Figure 2, in chart, the horizontal axis should be labeled "Time in minutes."

In paper "A New Approach to the Cosmic Red-Shift...., " the following errors were made

Printed error	Should be
p. 80, Fig. 2: $p_1 = m, v_1$	$p_1 = m_1 v_1$
p. 81, Eq. 4: $m_1 v_1 = mv + m_{fc}$	$m_1 v_1 = mv + m_f c$
p. 83, Eq. 13: $m_1 = m + m_f + \Delta m_{el}$	$m_1 = m + m_f - \Delta m_{el}$
p. 86, Eq.: $v = \frac{E}{B}$	$v = \frac{E_1}{B_1}$

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