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RESEARCH ARTICLE

Towards Reconciliation and Collaboration: Bridging Low Energy Nuclear Reactions and Mainstream Nuclear Physics

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ABSTRACT

Low Energy Nuclear Reactions (LENR), often associated with the controversial history of "cold fusion," have persisted as a topic of scientific interest for over three decades, despite limited acceptance in mainstream nuclear physics. While the LENR community has documented anomalous thermal effects and transmutation phenomena in metal-hydrogen systems, these results remain underexplored by conventional nuclear theory and experimental frameworks. This paper proposes a constructive path forward: a call for interdisciplinary collaboration between LENR researchers and mainstream nuclear physicists. We examine how such cooperation could enhance the reproducibility, theoretical interpretation, and credibility of LENR investigations, while simultaneously offering nuclear physics a unique opportunity to revisit unexplained low-energy phenomena. Through a synthesis of both communities' strengths, we argue that a collaborative scientific effort can lead to new insights, potential breakthroughs, and the resolution of long-standing anomalies. The reality of nuclear reactions in the original Fleischmann-Pons electrolytic cell can be newly interpreted if we will analyze the joint contributions of all active nuclei contained in that cell: in the PYREX glass, the used solution D_2O with 0.1 mol/l LiOD, Pd/D cathode, Pt anode, brass resistance heater, thermistor temperature probe, and the Kel F support plug. The simultaneous action of those nuclei can create excess heat that cannot be explained by chemical reactions. These "hidden" nuclear reactions effectively protected an acceptable interpretation based on the standard nuclear physics.

Keywords: Fleischmann-Pons experiment, hidden nuclear reactions, observed excess heat, Teller's electron catalysis.

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1. Introduction

Since the announcement by Fleischmann *et al*. [1] in 1989 of anomalous heat production in electrochemical cells – interpreted as evidence of "cold fusion"-the field now known as Low Energy Nuclear Reactions (LENR) has occupied a controversial space in modern science. While initial enthusiasm gave way to widespread skepticism due to replication difficulties and theoretical ambiguities, e.g., [2], [3]; a dedicated community of researchers has continued to pursue the subject with improved experimental techniques and a growing body of evidence suggesting real, though not yet fully understood, phenomena, e.g., [4]–[24].

Meanwhile, the field of mainstream nuclear physics has made enormous strides in understanding nuclear structure, reactions, and the fundamental forces governing atomic nuclei. It relies on well-established protocols and robust theoretical frameworks derived from quantum mechanics and the Standard Model. However, certain low-energy anomalies observed in condensed matter systems-such as excess heat, unexpected isotopic shifts, and possible low-level neutron or radiation emissions – remain insufficiently explained within the conventional nuclear paradigm.

This paper argues that the time is ripe for a re-evaluation of the divide between LENR and conventional nuclear physics. Rather than persisting in parallel – and often isolated – tracks, these communities can mutually benefit from deeper collaboration. LENR researchers bring decades of hands-on experimentation and observation of unique phenomena in metal-hydrogen systems. Nuclear physicists bring sophisticated tools for modeling, measurement, and theoretical analysis. Together, they can design more rigorous, controlled experiments; re-examine the fundamental assumptions about nuclear reactions in condensed matter; and foster a new generation of scientific inquiry unconstrained by disciplinary boundaries.

2. Chemical Composition of Parts in the Fleischmann-Pons Cell

The experimental cell used by Fleischmann *et al*. [4] in their calorimetric experiments was composed from several parts as it is depicted in Fig. 1. A brief review of alternative calorimetric cells was published by Storms [25].

Table I summarizes the chemical composition of these parts inserted into the Fleischmann-Pons calorimetric cell. We assume that nuclear reactions among these nuclei might collectively contribute to the observed excess heat.

3. Beta Electrons as the Trigger of Nuclear Reactions in the FPE

In October 1989, Teller [26] proposed a theoretical framework involving electron catalysis as a potential explanation for the anomalous effects associated with cold fusion, specifically at the femtometer scale. In his model, the interaction of electrons with nuclei could lead to the formation of previously unrecognized neutral nuclear configurations capable of penetrating the Coulomb barrier without the need for high kinetic energies. These configurations, potentially involving tightly bound electron-nucleus systems, would allow for nuclear processes to occur under conditions far less energetic than those required in conventional fusion reactions. Notably, Teller suggested that the electron catalysts are not consumed in the course of these reactions; rather, they may be recycled, enabling sustained nuclear activity with only a small number of catalytic electrons. This concept opens the

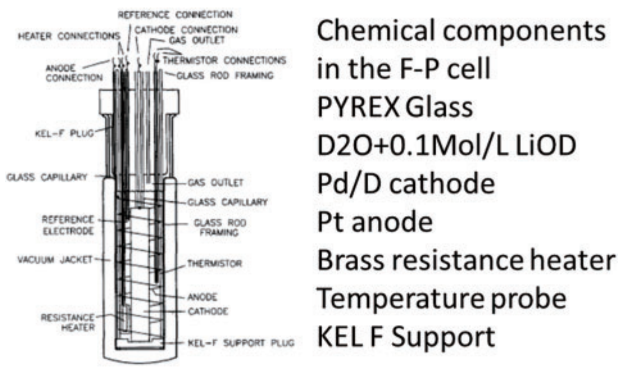

Fig. 1. The Fleischmann-Pons calorimetric cell used in their experiments.

TABLE I: Chemical Composition of Parts in the Fleischmann-Pons Calorimetric Cell

Chemical composition of parts in the Fleischmann-Pons electrolytic cell
PYREX glass cell 4.0% B, 54.0% O, 2.8% Na, 1.1% Al, 37.7% Si, 0.3% K
Solution in the cell $D_2O + 0.1$ mol/l LiOD
Cathode: Pd/D Anode: Pt
Brass resistance heater e.g., 67% Cu and 33% Zn
Thermistor temperature probe Composition not known
Kel F support plug (polychlorotrifluroethylene) $[-CF_2 - CFCl-]_n$

TABLE II: The Electron Multiplication Factor in the Fleischmann-Pons Experiment

Electron multiplication factor k in the Fleischmann-Pons experiment	Reference
k < 1 poisonous electron catalysis	[2], [3]
1 < k < critical value-active electron catalysis	[4]–[24]
k > critical value ("a substantial portion of the cathode fused – melting point 1544 °C, part of it vaporized, and the cell and contents, and part of the fume cupboard housing the experiment were destroyed")	[1]

TABLE III: Nuclei Present in the Fleischmann-Pons Cell that Could Trigger Nuclear Reactions

${}^{27}_{13}Al + {}^{1}_{0}n \rightarrow \left({}^{28}_{13}Al\right)^*$	
$\left({}^{28}_{13}Al\right)^* \rightarrow {}^{28}_{14}Si + {}^{0}_{-1}e \uparrow \left(t_{1/2} = 2.25\, min\right)$	$Q = 4.13\ MeV$
${}^{19}_{9}F + {}^{1}_{0}n \rightarrow \left({}^{20}_{9}F\right)^*$	
$\left({}^{20}_{9}F\right)^* \rightarrow {}^{20}_{10}Ne + {}^{0}_{-1}e \uparrow \left(t_{1/2} = 11.01\, s\right)$	$Q = 6.51\ MeV$
${}^{2}_{1}H + {}^{0}_{-1}e \rightarrow {}^{2}_{0}n$	$Q = -2.50\ MeV$

possibility for a class of low-energy nuclear reactions in which electrons play an active, regenerative role in mediating otherwise forbidden nuclear transitions.

We can introduce the electron multiplication factor k that describes these reactions:

$$k = \frac{\text{catalytic electrons out}}{\text{catalytic electrons in}} \tag{1}$$

Table II summarizes three different situations that were already observed during the Fleischmann-Pons experiments.

Table III collects two cases when nuclei present in the Fleischmann-Pons calorimetric cell can capture low energetic neutrons from the surroundings. These low energetic neutrons were observed by Jones *et al*. [5]. In the following beta decay, energetic beta electrons might trigger nuclear reactions in the Fleischmann-Pons cell. These beta electrons might react with deuterons under the formation of dineutrons.

Stávek analyzed the historical papers of founding fathers of nuclear physics [27]–[29] and formulated the Rutherford-Harkins-Landau-Chadwick Key [30]–[35] based on inspirative papers of Rutherford [36], Harkins [37]–[39], Landau [40]–[42], and Chadwick [43].

In this century many nuclear physicists have been studying the properties of dineutron, trineutron and tetraneutron, e.g., [44]–[62]. At this moment the structures of those neutral nuclei are not known.

4. Nuclei with High Neutron Capture Cross Sections

The Pd/D system has to be activated using beta electrons in order to create dineutrons that might freely travel throughout the Fleischmann-Pons cell. These dineutrons could be captured by nuclei with a high neutron capture cross section. Tables IV and V summarize nuclei present in the Fleischmann-Pons cell with a high neutron capture cross sections (data measured for the single neutron capture).

Miley *et al*. [63] analyzed in details properties of palladium nuclei in order to bring a better view into the processes occurring in the Pd/D system. They found that one important property of palladium

TABLE IV: The Natural Abundances and Cross Sections for the Neutron Capture for Pd Isotopes [59]

Isotope	^{102}Pd	^{104}Pd	^{105}Pd	^{106}Pd	^{108}Pd	^{110}Pd
Atomic %	1.0	11.0	22.2	27.3	26.7	11.8
Barns metastable	5.0	?	10.0	0.013	0.20	0.02
Barns stable-state	?	10.0	**90.0**	0.28	12.00	0.21

TABLE V: Nuclei with High Neutron Capture Cross Sections Present in the Fleischmann-Pons Cell [61]

Interaction	Energy T_n	Cross-section [barns]	Q-value [MeV]	Products
^{10}B(n,α)	Thermal	3840	2.792	Alpha, ^{7}Li
^{6}Li(n,α)	Thermal	940	4.78	Alpha, triton
^{105}Pd	Thermal	90	15.12	^{107}Pd
^{35}Cl	Thermal	43.6	18.89	^{37}Cl

TABLE VI: Dineutron Capture by Active Nuclei in the Fleischmann-Pons Calorimetric Cell

${}^{10}_{5}B + {}^{2}_{0}n \rightarrow \left({}^{12}_{5}B\right)^{*}$	$Q = 14.82\,MeV$
$\left({}^{12}_{5}B\right)^{*} \rightarrow {}^{12}_{6}C + {}^{0}_{-1}e \uparrow \left(t_{1/2} = 20.20\,ms\right)$	$Q = 12.85\,MeV$
${}^{6}_{3}Li + {}^{2}_{0}n \rightarrow \left({}^{8}_{3}Li\right)^{*}$	$Q = 9.28\,MeV$
$\left({}^{8}_{3}Li\right)^{*} \rightarrow \left({}^{8}_{4}Be\right)^{*} + {}^{0}_{-1}e \uparrow \left(t_{1/2} = 838\,ms\right)$	$Q = 15.49\,MeV$
$\left({}^{8}_{4}Be\right)^{*} \rightarrow 2{}^{4}_{2}He \quad \left(t_{1/2} = 81\,as\right)$	$Q = 0.09\,MeV$
${}^{105}_{46}Pd + {}^{2}_{0}n \rightarrow {}^{107}_{46}Pd$	$Q = 16.09\,MeV$
${}^{35}_{17}Cl + {}^{2}_{0}n \rightarrow {}^{37}_{17}Cl$	$Q = 18.89\,MeV$
Calculated excess heat per one helium 4 is 43.75 MeV/${}^{4}_{2}$He	
Edmund Storm's analysis [20] and [25] of 16 measurements by four independent studies $1.5 \times 10^{11}\,{}^{4}_{2}\text{He}/(\text{Ws}) = (43 \pm 12)$ MeV/${}^{4}_{2}$He	

nuclei is their neutron capture cross section. The natural abundances of the Pd isotopes and their cross sections for the neutron capture are listed in Table IV.

Data given in Table IV illustrate that the neutron capture is favored in Pd-105. Rolison and O'Grady analyzed the Pd cathodes used in the experiment of Fleischmann, Pons and Hawkins and found isotopic shifts of palladium nuclei [64]. They reported a diminution of palladium-105.

In the first step, the electron catalysts create dineutrons in the Pd/D system. In the second step these dineutrons have to be captured by some nuclei with high neutron capture cross sections. After these absorption reactions several transmutations and isotopic shifts occur and excess heat can be observed. This idea was already experimentally studied by Miles and Imam in their Pd/D/Boron system [21]–[24], where boron nuclei were inserted into the palladium cathode. In our model we assume that some other nuclei in the surroundings of the palladium cathode might be participants in nuclear reactions. Table V summarizes nuclei present in the FP cell with their neutron capture cross section with thermal neutrons.

5. Transmutations and Isotopic Shifts of Nuclei after the Dineutron Capture

Nuclei with high neutron capture cross sections, present in the surroundings of the palladium cathode, undergo several nuclear reactions and release excess heat observed in the Fleischmann-Pons calorimetric cell. Table VI summarizes nuclear events of these active nuclei based on the experimental data of nuclear physics.

Storms [20] and [25] analyzed 16 measurements by four independent studies where the amount of helium-4 was determined for observed excess heat produced by electrochemical cells containing D_2O and LiOD. The peak of his histogram gives the value (43 ∓ 12) MeV/^{4}He. The calculated excess heat for the Fleischmann-Pons calorimetric cell based on the dineutron capture by active nuclei gives 43.75 MeV/^{4}He.

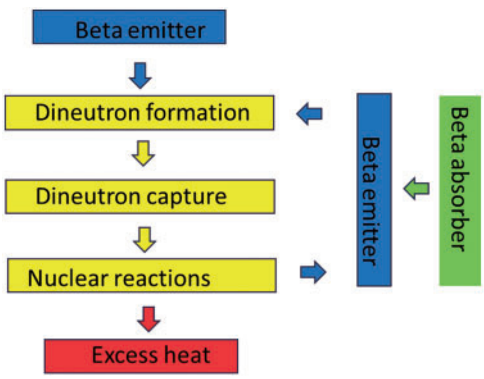

Fig. 2. The controlled Fleischmann-Pons experiment based on the controlled Teller's electron catalysis.

6. The Controlled Fleischmann-Pons Experiment

The principle of the controlled Fleischmann-Pons experiment is shown in Fig. 2 During the induction period a convenient beta emitter emits beta electrons towards the Pd/D cathode. Dineutrons have been formed inside of this Pd cathode and freely migrate into the surroundings of this central source of dineutrons. Active nuclei with high neutron capture cross sections absorb these dineutrons and according the rules of the standard nuclear physics nuclear reactions occur. The secondary beta electrons continue in a sustained chain reaction. The combination of nuclear reactions proceeds, the electron catalysts have been recycled. The beta electron concentration has to be controlled using a beta absorber. This manipulation of the Fleischmann-Pons system avoids the possible supercritical state with some undesired situations, e.g., [1], [65]–[67].

7. Conclusion: Towards a Shared Scientific Horizon

The LENR field offers persistent anomalies that challenge existing paradigms, while mainstream nuclear physics provides the rigor and tools necessary to evaluate such claims. Both communities stand to benefit from collaboration, not confrontation. In the spirit of pioneers of nuclear science, we propose a shared responsibility to follow the evidence, test our assumptions, and engage in honest scientific enquiry.

The way forward lies in openness, humility, and a commitment to excellence. Whether LENR phenomena lead to revolutionary technologies or simply refine our understanding of complex systems, the journey will enrich nuclear science as a whole. Let us meet not in opposition, but at the frontier – where questions are still open, and discovery still possible.

The stakes of this collaboration are high. If LENR phenomena can be fully understood and harnessed, they may offer pathways to safe, distributed, and sustainable energy sources – goals aligned with the broader mission of science to serve humanity.

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Conflict of Interest

The author declares that there is no conflict of interest.

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