[In 2006, Allan Widom, a condensed matter physicist with Northeastern University, and Lewis Larsen, president and CEO of Lattice Energy LLC, published a theory called *Ultra Low Momentum Neutron Catalyzed Nuclear Reaction*s in *European Physical Journal C.* They have declined to respond to inquires by many individuals, including this editor. We have found one posting by Mr. Larsen on the Chem Forums Web site from April 24, 2007 that answers questions that are on the minds of many people.

- Steven B. Krivit, Editor, *New Energy Times*.]

Mitch, Maz, and Borek:

Please note that there are short, "plain English" summaries of our four published papers down below. They will hopefully provide you with a high-level conceptual overview of what we are doing in each of our papers before having to delve into the details of the physics and mathematics.

Using the Widom-Larsen theory, we can now answer three important questions about anomalous LENR experimental results that previous "cold fusion" researchers have been unable to answer to the satisfaction of the mainstream physics community for the past 18 years. These questions and our answers to them are:

Question 1 - If LENRs are truly based on the process of fusing two positively charged deuterons, then how is the Coulomb repulsion barrier overcome at the moderate temperatures and pressures that prevail in LENR laboratory experiments? It is well known that stars such as our sun require temperatures of millions of degrees and enormous pressures to trigger nuclear fusion.

Widom and Larsen answer - LENRs do not involve strong interaction fusion of charged deuterons or protons. Rather, LENRs involve the weak capture of surface electrons (bathed in a soft electromagnetic radiation field) by collectively oscillating "patches" of protons or deuterons located on metallic hydride surfaces. Under such conditions, protons or deuterons in the "patches" can react directly with surface electrons, thereby producing "ultracold" ultra low momentum neutrons which then function as uncharged "nuclear catalysts." Such neutrons are always locally absorbed by nearby nuclei, triggering additional "weak" nuclear transmutation reactions (which create different chemical elements) and the release of heat. Importantly, there are no Coulomb barriers to such weak interactions; so extremely high temperatures and pressures are not required, as is the case with strong interaction fusion processes. The neutrinos that are always produced when neutrons are created simply radiate off into space; they don't really interact locally with anything on Earth.

Question 2 - Why aren't large quantities of high momentum (energetic) neutrons produced in LENR systems, as would be expected from typical nuclear fusion or fission processes?

Widom and Larsen answer - As stated above, weak interaction nuclear reactions are not Coulomb barrier penetrating as would be the case with strong interaction nuclear fusion. Furthermore, the initial weak nuclear interactions produce only ultra low momentum neutrons that are locally absorbed by nearby nuclei. Accordingly, we would not expect biologically significant quantities of energetic neutrons to be externally detected in LENR systems, which is exactly what has been observed in thousands of experiments.

Question 3 - Why aren't large quantities of "hard" gamma/X-ray radiation seen in LENR experiments that have also produced substantial amounts of excess heat and/or nuclear transmutations? It is widely appreciated that the anomalously large excess heat and/or transmutations observed in LENR experiments cannot be explained by a chemical process without invoking nuclear reactions. However, typical nuclear processes such as fission or fusion would be expected to emit copious, lethal doses of energetic X- and gamma rays during experiments. So, why aren't all the many LENR experimentalists dead from hard radiation poisoning?

Widom and Larsen answer - The expected gamma rays are in fact produced when ultra low momentum neutrons are locally absorbed by nuclei in LENR systems. However, surface electrons bathed in "soft" low energy radiation also have the unique ability to quickly and efficiently absorb "hard" gamma rays and convert the gammas' energy into other "soft" radiation --- that is, mostly into the form of many more soft infrared photons (heat). Thus, in LENR systems, hard gamma ray photons in the energy range between 0.5 MeV and 10.0 MeV are locally absorbed and converted directly into heat. Importantly, in the relatively rare cases in which gamma radiation has been detected experimentally in LENR systems, the observed quantities of hard radiation are relatively small (not biologically significant) with energies that are strongly suppressed above about 0.5 MeV, exactly as predicted by our theory. So, LENR systems have intrinsic built-in gamma shielding, a remarkable property by any standard.

According to our theory, primary end-products of LENRs include stable isotopes, beta and alpha particles, "soft" electromagnetic radiation (in most LENR systems, predominantly infrared along with some barely measurable amounts of low-energy X-rays), and neutrinos. The ~1 MeV electron neutrinos, of course, radiate without any consequence into the environment.

Also according to our theory, in LENR systems, extremely neutron-rich, unstable intermediate reaction products turn into stable elements very quickly via cascades of rapid beta decays. In the case of LENRs, these very neutron-rich intermediates probably have half-lives measured in milliseconds, seconds, minutes, or at most hours --- typically not days, months, or many years. We believe that this is exactly why LENR systems do not produce large quantities of long-lived radioactive isotopes like existing commercial fission reactors; importantly, there are no known nuclear waste disposal issues with LENR systems.

Generally, X-rays, when detected, comprise small fluxes of "soft" photons. Biologically dangerous quantities of really "hard" (MeV+ energy) X- and/or gamma rays have never been observed in thousands of experiments with LENR systems over 18 years.

In our opinion, the phenomenon of LENRs is not predominantly strong interaction fusion or fission. According to our work, LENRs are mainly driven by the weak interaction. Sadly, the "cold fusion" people have doggedly pursued an incorrect D-D fusion paradigm since 1989. That problem, along with substantial misdirection of experimental work and other related "wheel spinning," is one of the many reasons why the field stagnated for so long, as noted in numerous critical comments made by outside scientists during the last Department of Energy "cold fusion" review panel back in 2004.

(1) Eur. Phys. J. C **46**, 107-111 (2006), "Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces"

The mass of electrons embedded in collectively oscillating surface plasma oscillations can be markedly increased (renormalized) by the extremely high electric fields (> 10*11 volt/meter) occurring in surface layers of protons or deuterons of loaded metallic hydrides. The resulting "heavy" electrons can react spontaneously with local protons or deuterons to produce neutrons and neutrinos. Neutrons created collectively under these conditions have almost virtually zero momentum or equivalently very long quantum mechanical wavelengths which dramatically increase neutron absorption in the neighborhood of condensed matter surfaces. These ultra low momentum neutrons can catalyze local nuclear reaction networks. Examples of such reactions are provided.

(2) http://www.arxiv.org/pdf/cond-mat/0509269, "Absorption of Nuclear Gamma Radiation by Heavy Electrons on Metallic Hydride Surfaces"

This preprint (submitted to a refereed journal) provides a theoretical explanation for effective suppression of gamma radiation and efficient absorption of ultra low momentum neutrons in LENR systems. It is explained why neutron absorption by nearby nuclei in LENR systems do not result in the external release of large, easily observable fluxes of hard energetic gammas and X-rays. Specifically, we show that surface electrons bathed in already soft radiation can convert the hard gamma radiation into soft radiation. The number of gammas in the energetic region from 0.5 MeV to 10.0 MeV is strongly suppressed at the condensed matter surface and the energy appears as softer (less energetic) heat radiation. The short mean free paths of both ultra low momentum neutrons and hard gamma radiation are computed in the neighborhood of condensed matter surfaces. In LENR systems, the gamma absorbing layer of surface electrons already bathed in soft radiation has the ability to stop a very dangerous ~5 MeV gamma ray in less than two nanometers -- two-billionths of a meter. With existing materials technologies, it would take ~10 cm of lead, ~25 cm of steel, or ~1 meter of very heavy concrete to accomplish the same degree of shielding.

(3) http://www.arxiv.org/pdf/cond-mat/0602472, "Nuclear Abundances in Metallic Hydride Electrodes of Electrolytic Chemical Cells"

This preprint (submitted to a refereed journal) discusses a model for the anomalous patterns of nuclear abundances experimentally observed in metallic hydride cathodes of electrolytic chemical cells. These experimental transmuted nuclear abundances have been something of a scientific enigma since they were first published by Prof. George H. Miley in the Dept. of Nuclear Engineering of the University of Illinois at Urbana-Champaign. The data is interpreted as primarily the result of a neutron absorption spectrum. Ultra low momentum neutrons are produced (along with virtually inert neutrinos) by the weak interaction annihilation of electrons and protons when the chemical cell is driven strongly out of equilibrium. Appreciable quantities of these neutrons are produced on the surface of a metal hydride cathode in an electrolytic cell. The ultra low momentum of these neutrons implies extremely large cross-sections for absorption by various "seed" nuclei present on or near the surface of a cathode in a chemical cell, increasing their nuclear masses. The increasing masses eventually lead to instabilities relieved by beta decay processes, thereby increasing the nuclear charge. In this manner, "…most of the periodic table of chemical elements may be produced, at least to some extent." The experimentally observed pattern of distinctive peaks and valleys in the transmuted nuclear mass-spectrum reflect the neutron absorption resonance peaks as theoretically computed employing a simple and conventional neutron optical model potential well. An intriguing possibility is briefly noted in the paper. The varieties of different elements and isotopes that we find in the world around us were thought to arise exclusively from nuclear reactions in stars and supernova explosions. However, recent astrophysical calculations have indicated some weaknesses in the above picture regarding the strengths of the neutron flux created in a supernova. Our paper suggests that, "It appears entirely possible that ultra low momentum neutron absorption may have an important role to play in the nuclear abundances not only in chemical cells but also in our local solar system and galaxy."

(4) http://www.arxiv.org/pdf/nucl-th/0608059, "Theoretical standard model rates of proton to neutron conversions near metallic hydride surfaces"

This latest paper (submitted to a refereed journal) aims to answer an important question posed by many astute readers of our earlier publications on this subject. Assuming that one believes the rest of our physics, can we show computations demonstrating that these claimed proton to ultra low momentum neutron conversions can take place at the substantial rates observed in the laboratory?

In this preprint, we discuss how to compute low energy nuclear reaction rates for the process of radiation-induced electron capture by protons or deuterons producing new ultra low momentum neutrons and neutrinos. For protons or deuterons in the neighborhoods of surfaces of condensed matter metallic hydride chemical cell cathodes, the radiation energy required for such nuclear reactions may be supplied by the applied voltage required to push a strong charged electric currents through certain chemical cells. The rates of the resulting ultra low momentum neutron production are computed from the standard electroweak theory in satisfactory agreement with the available experimental data.

I hope that this helps answer some of your questions. Sorry for the long-winded answer, but given the points that you all raised, I wanted to provide you with more than just a "sound bites" response.

[Ed: Widom and Larsen released a fifth paper subsequent to the communication above. The following text accompanied the release of the paper.]

We have attached a new 3-page preprint, "*Energetic Electrons and Nuclear Transmutations in Exploding Wires*," arXiv:0709.1222v1 [nucl-th] 8 Sep 2007 by Widom, Srivastava, and Larsen. In this paper, we extend our theory of low energy nuclear reactions (LENRs) beyond the domain of relatively low temperature chemical cells to include closely related nuclear phenomena that occur in much more energetic, violent environments associated with high-current exploding wires.

One aim of our paper is to resolve an old controversy. In 1922, Wendt &Irion, two chemists from the University of Chicago, reported the results of relatively simple experiments that consisted of exploding tungsten wires with a very large current pulse under a vacuum inside of sealed glass "bulbs." A huge controversy erupted because Wendt &Irion claimed to have observed the presence of anomalous helium inside sealed bulbs after the tungsten wires were blown, suggesting that transmutation of hydrogen into helium had somehow occurred during the "*disintegration of tungsten.* " Widespread press coverage triggered a response from the scientific establishment in the form of a negative critique of Wendt &Irion's work by Ernest Rutherford that was published in *Nature*. Rutherford won the contemporary debate; he was believed --- Wendt &Irion were not. After 1923, Wendt and Irion abandoned their exploding wire experiments and turned to other lines of research.

Until recently, this controversy had been almost totally forgotten. However, it now appears to us that Rutherford was incorrect in his criticisms; Wendt and Irion *were* right. First, we cite recent experimental evidence on exploding wires that decisively settles the experimental issues in favor of Wendt &Irion. Neutrons *are* produced in such experiments, making it entirely plausible that nuclear transmutations can occur. Second, we cite additional recent experiments in which, "*fast neutrons have been seen in exploding wires even though there were no deuterons initially present.* " Since distinctive gamma signatures have not been observed along with any such neutrons, it appears unlikely to us that D-D fusion is the mechanism responsible for producing them.

We also aim to resolve the remaining theoretical issues. Utilizing collective effects with electrons in wires, well-established physics, and only four equations, we go on to explain a "*theoretical paradox in low energy nuclear reactions that has remained unresolved for over eight decades.*"

We conclude that, "*It is presently clear that nuclear transmutations can occur under a much wider range of physical conditions than was heretofore thought possible.*"

The resolution of this 85 year-old controversy is especially poignant when one considers that: (a.) in 1920 Rutherford himself had predicted the existence of a neutral nuclear particle with ~ the same mass as a proton, saying that *it could be formed by the capture of an electron onto a proton* ;(b.) the existence of the neutron would not be experimentally verified by James Chadwick until 1932; and (c.) fission would not be discovered by Otto Hahn and Fritz Strassman until 1938.

Since they can be difficult to obtain, for your convenience we have attached a second Adobe Acrobat document that contains copies of all three original publications as follows: (1.) Wendt and Irion's initial paper, "*Experimental Attempts to Decompose Tungsten at High Temperatures*," from the *Amer. Chem. Soc.* 44 (1922); (2.) Rutherford's comments about their work in *Nature* 109 418 (1922) - also reprinted with permission in *Science* (attached); and (3.) Wendt's subsequent response to Rutherford in *Science* 55 567 (1922).