May 4-5, 2009

COLD FUSION: REALITY or FICTION ?

Larry Forsley reports on his research at the US Navy

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The First Colloquium on Nano-Nuclear Science
l'Université catholique de Louvain
May 4 – 8, 2009

Lattice Assisted Nuclear Reactions
Overview of an Unexpected Phenomena

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Twenty years ago Professors Martin Fleischmann and Stanley Pons at the University of Utah announced they had discovered evidence of excessive exothermic reactions with a palladium cathode undergoing heavy water electrolysis. Their calculations showed the reactions exceeded the energy of known chemistry implying a nuclear phenomena which the press rapidly coined "cold fusion". Yet, many august laboratories throughout the world were unable to replicate the purported findings. Within a year, cold fusion was deemed dead.

However, small groups groped with tantalizing tidbits of data. Not only was excess heat sometimes seen, but occasionally the apparatus melted! Peer reviewed papers reported sightings of tritium and elemental transmutation. Other evidence of nuclear reactions began to appear including x-rays, gamma rays, charged particles and neutrons. Very early on excess heat was linearly correlated with helium 4 nuclear "ash".

Many theories evolved regarding how this could be. The late Nobel Laureate, Julian Schwinger, considered nuclear reactions in the palladium lattice possible. Yet, even the possibility of this peculiar phenomena's acknowledgment by one of the founders of quantum mechanics couldn't still the physics' community's outrage over a couple of chemists poaching on their territory: not to mention the impact on multi-billion Euro hot fusion programs if one could do the same with an infinitely cheaper bottle of heavy water and a hundred grams of palladium.

It is now known and recognized in the peer reviewed literature that there are conditions under which a heavily deuterium loaded palladium lattice will produce correlated heat and helium-4, and, under different conditions, charged particles and neutrons consistent with hot fusion deuterium-deuterium (DD) and deuterium-tritium (DT) fusion reactions. High resolution X-ray and gamma ray spectroscopy have provided insight into the detailed mechanisms. Although there are now experiments that reliably reproduce heat and/or nuclear particles all of the time, as yet there is no theory that adequately describes all of the observed results.

This is an introductory talk.

An experimental protocol for exploring nano-nuclear science

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The "Cold Fusion" community has been justifiably criticized for not providing a standard protocol that one, "skilled in the art" could consistently, and reliably, carry out. Indeed, the phenomena's irreproducibility is both its hallmark feature and its curse. However, at the request of Steven Krivit, of New Energy Times, Dr. Pam Boss, of the US Navy SPAWAR-Pacific developed a co-deposition protocol for The Galileo Project. This protocol demonstrably and repeatedly produced charged particles and neutrons from a palladium cathode electrolyzed in heavy water.

Senior year chemistry students at the University of California, San Diego successfully followed the protocol*, more or less*, in three successive classes. One of the groups had a poster session presented at the 8th International Workshop on Anomalies in Hydrogen / Deuterium Loaded Metals in Catania, Sicily in 2007. An entire session at that workshop was devoted to nuclear co-deposition using the Galileo Project Protocol. Several groups discussed the charged particle and neutron recoil tracks seen including observations from a BF_3 neutron detector used by SRI of Menlo Park, CA.

The Galileo Project Protocol is a reliable, successful and easily operable means to produce MeV energy charged particles and neutrons using co-deposition in less than a week. Consequently, it provides a "lab rat" to explore the nano-nuclear science realm. Although this experiment incorporates a solid state nuclear track detector, it also lends itself to a variety of other nuclear, chemical, and material science diagnostics. There is no shortage of questions raised in this system!

This talk is at an intermediate level and discusses past experiments and the protocol in detail.

Two Channels: Evidence for aneutronic and conventional fusion in an unconventional place

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"The Dead Graduate Student Problem" came to exemplify the initial hot fusion community's reaction to Fleishmann's and Pons' 1989 announcement of "fusion in a jar". If deuterium fusion generated as much heat as suggested, then the neutron flux would have killed anyone in the room. Since there were no reported bodies, the absence of dead graduate students came to prove the absence of fusion. Yet, a few years later the peer-review published results of Dr. Mel Miles correlating heat and helium ash *without* commensurate neutrons or gamma radiation suggested the existence of an aneutronic fusion channel.

However, researchers in Italy, India and Japan have repeatedly published evidence of low level neutron emissions. Many researchers have reported tritium, often anti-correlated with heat. Recently published work by Boss, *et al*, has characterized the neutron energy, but, without measurable heat. Consequently, there may be two different nuclear channels in condensed matter nuclear science: one producing heat and helium ash without detectable nuclear emanations and the other producing "conventional" hot fusion and other reactions in an unconventional place. The existence of these channels, and the ability to cross between them, and correlate nuclear emissions, or their absence, with experimental parameters provides the means to understand the phenomena.

This technical talk will review the past and current data thus presented and discuss theories offered as to the underlying mechanisms.

The Wider Phenomena: Electron Screening, nuclear cross-sections, astrophysics and superconductivity

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The 1989 announcement by Fleischmann and Pons regarding "fusion in a jar" was met with considerable criticism and downright ridicule. Yet, there have been several astronomical phenomena whose elemental abundances and isotopic compositions are at odds with the Standard Model in physics. It has been posited that the low-energy nuclear cross-sections, as inferred from high energy particle physics, may be in error. It is suspected that this error may be do to the underappreciated effects of electron screening. A similar effect has been theorized in metal lattices. Experimental work has shown measurable changes in isotope half-lives involving K-shell electrons. Superconductivity in heavy loaded palladium hydride and palladium deuteride systems may also be affected by electron screening.

This technical talk will examine the curious case of the misplaced middle, or how physicists skipped over low energy nuclear cross-sections on their race to build bigger accelerators.

Lawrence P. G. Forsley

Lawrence P. G. Forsley is president of JWK International Corporation and has been a long time collaborator and co-author with the US Navy SPAWAR-Pacific. Previously, he was a group leader with the Laboratory for Laser Energetics engaged in inertial confinement fusion (ICF, or, laser fusion) at the University of Rochester in Rochester, NY (USA). He was a consultant to the Lawrence Livermore National Laboratory mirror fusion program, TMX-U, in Livermore, California (USA) and a visiting scientist on the ASDEX Tokamak at the Max Planck Institut fur Plasmaphysik in Garching, Germany.

Mr. Forsley initiated a US Navy ONR-funded program at the Naval Research Laboratory into the basic science of sonoluminescence, or light emitted from cavitating bubbles, and he observed gamma rays. Subsequently, he participated in DARPA sonofusion program reviews, including the work of Dr. Rusi Taleyarkhin. Dr. Jacob Jorne and Mr. Forsley conducted bulk palladium electrolysis experiments at the University of Rochester under the baleful eye of Dr. John Huizenga. In cooperation with Clean Energy Technologies, Inc. and the Naval Research Laboratory, Mr. Forsley and Dr. Jim Patterson developed a fluidized bed using uranium and thorium ceramics.

For the past several years he has worked closely with Drs. Pam Mosier-Boss, Stan Szpak and Frank Gordon at SPAWAR where he has been developing and using charged particle and neutron diagnostics, and gamma ray detectors. These diagnostics temporally, spatially and spectrally resolve the nuclear emanations from palladium co-deposition experiments with high resolution cryogenically cooled germanium gamma ray detection, CR-39 solid state track detectors, witness materials, and both high resolution inductively coupled plasma mass spectroscopy (ICP/MS) and scanning electron microscopy (SEM) with x-ray flourescence analysis.

He is an author or co-author of over 30 peer reviewed papers, book chapters, conference presentations, and, most recently, "Triple tracks in CR-39 as the result of Pd–D Co-deposition: evidence of energetic neutrons" published in *Naturwissenschaften* in January, 2009.

In his spare time he's developed and deployed intelligent ground-based seismic sensors and used space-based Differential Interferometric Synthetic Aperture Radar (DInSAR) to monitor ground deformation.

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