The Rossi Ni + p Byproduct Riddle

Horace Heffner December, 2011

THE RIDDLE AND POSSIBLE SOLUTION

Deflation fusion theory provides a potential solution to the riddle of why the radioactive byproducts 59CU29, 61Cu29, 58CO27, and 62Cu29 to the Ni + p reactions do not appear in Rossi's E-cat byproducts. This solution of the missing radioactive byproducts problem is manifest if the following rules are obeyed by the environment, except in extremely improbable instances:

1. The initial wavefunction collapse involves the Ni nucleus plus two p*

2. As with all LENR, radioactive byproducts are energetically disallowed.

Here p* represents a deflated hydrogen atom, consisting of a proton and electron in a magnetically bound orbital, and v represents a neutrino. For prospective reactions producing these radioactive products see the reactions listed herein that include the hash mark symbol, "#".

The above two rules result in the following energetically feasible reactions:

58Ni28 + 2 p* --> 60Ni28 + 2 v + 18.822 MeV [-0.085]

60Ni28 + 2 p* --> 62Ni28 + 2 v + 16.852 MeV [-1.842]
60Ni28 + 2 p* --> 58Ni28 + 4He2 + 7.909 MeV [-10.786]
60Ni28 + 2 p* --> 61Ni28 + 1H1 + v + 7.038 MeV [-11.657]

61Ni28 + 2 p* --> 62Ni28 + 1H1 + v + 9.814 MeV [-8.777]

62Ni28 + 2 p* --> 64Ni28 + 2 v + 14.931 Mev [-3.560]
62Ni28 + 2 p* --> 64Zn30 + 13.835 MeV [-4.656]
62Ni28 + 2 p* --> 60Ni28 + 4He2 + 9.879 MeV [-8.612]
62Ni28 + 2 p* --> 63Cu29 + 1H1 + 6.122 MeV [-12.369]
62Ni28 + 2 p* --> 59Co27 + 4He2 + 1H1 + 00.346 MeV [-18.145]

64Ni28 + 2 p* --> 66Zn30 + 16.378 MeV [-1.918]
64Ni28 + 2 p* --> 62Ni28 + 4He2 + 11.800 MeV [-6.497]
64Ni28 + 2 p* --> 65Cu29 + 1H1 + 7.453 MeV [-10.843]

Ni28 + 2 p* ---> Ni28 + 2 1H1 + 0 MeV [+6 Mev ZPE]

The initial energy deficit due to trapped electrons is estimated in brackets, and is given by:

E = x*(Z-x)*(1.44E-9 ev m)/r

r = 0.85*(1.25E-15 m) * A^(1/3)]

where x=2 in this case due to 2p* reactions, and Z=28.

THE ZERO POINT ENERGY FUELED CASES

Note that in the case where a p* is ejected and results in a 1H1, ultimately a hydrogen atom, that the electron and proton are not ejected at the same time. The large positive nuclear charge ejects the proton immediately with approximately 6 MeV kinetic energy.

This kind of zero point energy fueled proton ejection should result in detectible brehmstrahlung. This energy is in addition to the mass change energy listed above. The approximately 6 MeV free energy so gained is made up from the zero point field via uncertainty pressure expanding any remaining trapped electron's wavefunction. Some energy may also be obtained from the direct magnetic attraction of a pair of deflated protons, without the aid of a lattice nucleus. This is of the form:

p* + p* --> 2 1H1

However, the repulsion of a proton from a proton is far less than from a large nucleus, and the electrons in this case are not trapped when the protons separate. However, some EuV radiation can be expected from the ensemble breakup. A very very small rate of pep reactions may occur:

p + p* --> D + e+ + v + 0.42 MeV

p* + p* --> D + e+ + e- + v + 0.42 MeV

These are followed immediately by:

e- + e+ --> 2 gamma + 0.59 MeV

and this gamma producing reaction was not observed above background in the Rossi E-cats.

COMPARISON WITH PURELY STRONG REACTIONS

The following represent energetically feasible initial strong reactions based on deflation fusion theory:

Compare to 18.822 MeV:

58Ni28 + p* --> 59Cu29 # + 3.419 MeV [-4.867 MeV]

58Ni28 + 2 p* --> 56Ni28 # + 4He2 + 5.829 MeV [-10.650 MeV]
58Ni28 + 2 p* --> 60Zn30 # + 8.538 MeV [-7.941 MeV]

Compare to: 16.852 MeV:

60Ni28 + p* --> 61Cu29 # + 4.801 MeV [-3.394 MeV]

60Ni28 + 2 p* --> 58Ni28 + 4He2 + 7.909 MeV [-8.391 MeV]
60Ni28 + 2 p* --> 62Zn30 # + 11.277 MeV [-5.022 MeV]

Compare to: 9.814 MeV

61Ni28 + p* --> 58Co27 # + 4He2 + 00.489 MeV [-7.661 MeV]
61Ni28 + p* --> 62Cu29 # + 5.866 MeV [-2.284 MeV]

61Ni28 + 2 p* --> 59Ni28 # + 4He2 + 9.088 MeV [-7.125 MeV]
61Ni28 + 2 p* --> 62Cu29 # + 1H1 + 5.866 MeV [-10.347 MeV]
61Ni28 + 2 p* --> 63Zn30 # + 12.570 MeV [-3.643 MeV]

Compare to: 14.931 Mev

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62Ni28 + p* --> 59Co27 + 4He2 + 00.346 MeV [-7.760 MeV]
62Ni28 + p* --> 63Cu29 + 6.122 MeV [-1.984 MeV]
62Ni28 + 2 p* --> 64Zn30 + 13.835 MeV [-2.293 MeV]

Compare to: 16.378 MeV

64Ni28 + p* --> 65Cu29 + 7.453 MeV [-0.569 MeV]
64Ni28 + 2 p* --> 66Zn30 + 16.378 MeV [00.415 MeV]

* Note - reaction products marked with # above are radioactive.

In all cases the net reaction energies of the proposed reactions exceed the net energies from reactions that produce radioactive isotopes. This makes rule 2 reasonable and understandable on an energy only basis. The mechanism that enforces the rule is more difficult to understand. Understanding the mechanism requires understanding the initial energy deficit due to the trapped electron. This electron trapping energy deficit is shown in brackets above. The deficit shown is a net of the Coulomb trapping energy less the nuclear reaction energy. This deficit provides a limit to how far an energetically ejected electron can travel out of the Coulomb well before being pulled back. For a description of the nature of the energy deficit see page 2 of:

http://www.mtaonline.net/~hheffner/CFnuclearReactions.pdf

Note that rule 2 is merely a heuristic rule. It specifies the most probable outcomes. Branching ratios are the result of stochastic processes. The most energetically favorable branch is not always taken. Radiactive products have been detected from many cold fusion experiments. The amount, however, is usually very small, and often difficult to detect due to either low counts, or low energies. For a discussion of the stochastic nature of branching ratios, especially in relaton to deflation fusion, see p. 3 ff of the above reference.

If an electron is in the nucleus at the site of the initial reaction, then a large part of the energy that normally goes into ejecting a gamma goes into ejecting the trapped electron. However, given that this ejection energy is insufficient, i.e. the number in brackets is negative, the electron has numerous delayed passes through the nucleus in which to effect a weak reaction. The electron, when outside the nucleus and accelerating, is free to radiate large numbers of gammas in much smaller than normal energies. Spin is supplied for photon radiation by spin flipping when the electron close approaches or transits the nucleus. It is also notable that the electron energy deficits in brackets are only initial lower limits. The actual energy deficit can be much higher, depending on the radius of the deflated proton or deflated quark involved.

THE MOST IMPORTANT ENTHALPY PRODUCING NUCLEAR REACTIONS

The neutrino producing reactions lose almost all their kinetic energy to the neutrinos. If these reactions are excluded, the following list is produced:

60Ni28 + 2 p* --> 58Ni28 + 4He2 + 7.909 MeV [-10.786] improbable
62Ni28 + 2 p* --> 64Zn30 + 13.835 MeV [-4.656]
62Ni28 + 2 p* --> 60Ni28 + 4He2 + 9.879 MeV [-8.612] improbable
62Ni28 + 2 p* --> 63Cu29 + 1H1 + 6.122 MeV [-12.369] improbable
62Ni28 + 2 p* --> 59Co27 + 4He2 + 1H1 + 00.346 MeV [-18.145] improbable
64Ni28 + 2 p* --> 66Zn30 + 16.378 MeV [-1.918]
64Ni28 + 2 p* --> 62Ni28 + 4He2 + 11.800 MeV [-6.497] improbable
64Ni28 + 2 p* --> 65Cu29 + 1H1 + 7.453 MeV [-10.843] improbable

The branches having less energy are marked improbable. The reaction energy appears in an exponential term (in the erfc function) when computing channel probability. See page 7 of:

http://www.mtaonline.net/~hheffner/CFnuclearReactions.pdf

Removing the improbable reactions, to obtain the most prolific heat producing reactions leaves:

62Ni28 + 2 p* --> 64Zn30 + 13.835 MeV [-4.656]
64Ni28 + 2 p* --> 66Zn30 + 16.378 MeV [-1.918]

This implies that, given the initially assumed two rules, Ni highly enriched in 62Ni and 64Ni will provide a much higher energy density. The natural abundances of 62Ni and 64Ni are 3.634% and 0.926% respectively. For this reason the reliability and energy density of reactors using nickel highly enriched in 62Ni and 64Ni should be significantly improved.

WHAT IS DEFLATION FUSION THEORY?

To provide some background, deflation fusion theory has evolved from this:

http://www.mtaonline.net/~hheffner/DeflationFusion.pdf

http://www.mtaonline.net/~hheffner/DeflationFusionExp.pdf

http://www.mtaonline.net/~hheffner/FusionSpreadDualRel.pdf

to this:

http://www.mtaonline.net/~hheffner/CFnuclearReactions.pdf

http://www.mtaonline.net/~hheffner/dfRpt

http://www.mtaonline.net/~hheffner/FusionUpQuark.pdf

http://www.mtaonline.net/~hheffner/PdFusion2.pdf

MAGNETISM AND DEFLATION FUSION

Magnetic orbitals involving electrons with either deuterons, protons, or positive quarks, are the essence of Deflation Fusion concepts.

The magnetic force due to spin coupling is a 1/r^4 force, while the Coulomb force is a 1/r^2 force. At close radii, the magnetic binding between electron and nucleating particle greatly exceeds the Coulomb force, though magnetically bound orbitals are intrinsically unstable, due to their 1/r^4 nature. The hydrogen electron is momentarily bound to its nucleus in a very small magnetic orbital periodically, but briefly, on the order of an attosecond. This is the deflated state. This magnetically bound small state, being neutral, but having a very large magnetic moment for a nucleus, has a significant probability of tunneling to any adjacent nucleus that has a magnetic moment. The magnetic gradients provide the net energy for tunneling of the neutral deflated state hydrogen to the adjacent nucleus.

Heavy lattice nuclei magnetic moments are periodically enhanced by electrons which enter the nucleus in their ordinary orbital states. That orbital electrons enter nuclei is evidenced by the facts that (1) they are point particles in valid QM treatments, with nonzero nucleus residence probabilities, and (2) electron capture by the nucleus is a real phenomenon. The magnetic moment of an electron is 3 orders of magnitude larger than typical nuclei. Some nuclei have no magnetic moment at all. Orbital electrons, when in a heavy nucleus, have the ability to form momentary small deflated state nuclear components within the heavy nuclei, and thus impart extremely large nuclear magnetic moments, three orders of magnitude larger than typical nuclei, to the heavy nuclei. When in the nucleus, the electrons can momentarily magnetically bind to nuclear particles, such as protons or quarks, including strange quarks, sometimes resulting in weak reactions between an electron and strange quark, thereby leaving behind unpaired strange matter. Strange quark pairs are produced from the vacuum in nuclei. If one strange quark is weakly transmuted, or catalytically extracted, then the paired strange quark remains behind in a potentially long term stable form. By deflation fusion theory, nuclear electrons have the ability to catalyze strange particle production from the vacuum and separate them, as well as produce low energy state, and thus stable, product particles. See page 20 ff. of:

http://www.mtaonline.net/~hheffner/CFnuclearReactions.pdf

This catalytic separation of strange matter rarely occurs in ordinary matter, not even enough to increase background radiation. However, the prolonged presence of trapped and energetic electrons within heavy nuclei that result from deflation fusion has a far more significant effect via (a) Coulombic prolonging of the lifetimes of strange pairs, enhancing the probability of strange matter in the nucleus, (b) the ability to isolate and catalytically free neutral kaons from a very unstable nucleus having 5 quarks, and (c) the ability of the trapped electron to directly engage in weak reactions with strange quarks.

This strange matter catalysis process, which is primarily magnetic force based, has the potential to produce and store antimatter, and to dwarf the capacity and energy density of all other methods of energy storage and production. The momentary extremely low energy state of deflated nuclei in a heavy nucleus reaction has the potential to produce stable and separated matter and antimatter strange particles, hyperons, and hyper nuclei. That is perhaps the most significant part of deflation fusion theory.

The formation of the deflated state in bare hydrogen nuclei, e.g. lattice absorbed nuclei, is feasible in an electron flux provided the flux density is high enough. This was theorized some years ago. A recent development, related to Brian Ahern's work, is the significance of magnetic vortices, i.e. electron vortices. These vortices produce a dense electron flux in the vicinity of absorbed hydrogen nuclei, and thus can be expected to greatly enhance the probability of the deflated state hydrogen nuclei in their presence.

Once an electron is momentarily trapped in a heavy lattice nucleus, and the nucleus has orders of magnitude larger magnetic moment, that nucleus can act as a nucleating point for numerous other deflated state hydrogen nuclei to tunnel into that heavy nucleus, thus trapping multiple new hydrogen nuclei and, their magnetically bound electrons, from every lattice locus nearby. In a dense lattice with a high deflated nucleus population density, this can be 4, 6, or 8 hydrogen nuclei. Depending on the duration the lattice nucleus retains a high magnetic moment, additional hydrogen nuclei can tunnel into the vicinity to occupy the sites vacated by the now fused hydrogen This general process can be called cluster fusion.

Nonmagnetic material can be made magnetic within nanopores, by creation of rings of free electrons at the nanopore metal boundary. Nickel itself can be magnetic or not, depending on the chemical loading processes and chemical nature of the nanopores in which it is embedded, and depending on the presence sometimes of a single iron atom.

These are some of the facts and theories behind this post regarding E-cats etc. last April:

http://www.mail-archive.com/vortex-l@eskimo.com/msg44662.html

Here the potential value of mu metal was discussed. An example of mu metal, 80% Ni, 14% Fe, 5% Mo, 0.5% Mn, plus trace S, Si, C, P, was provided. Its Curie temperature is about 454°C. The saturation induction is 7500 gauss, and permeability is 325,000. The permeability of mu metal is increased by a factor of 40 by baking it at high temperature in hydrogen. This hot hydrogen environment is most notably the environment of the E-cat. The only thing apparently lacking is the application of a large magnetic field.

Loading of nanopores with fusion lattice material, or even just using metallic glasses or amorphous materials, in addition to providing magnetic advantages, permits the application of extreme electric fields to the condensed matter in which fusion is to occur. This is because the small islands of active material are physically isolated by highly insulating dielectric material. Applying an external electrostatic field then permits electron concentration over a vast surface area, i.e. the production of volume dense high electron fugacity surfaces. The importance of electron fugacity was discussed starting on page 6 here:

http://www.mtaonline.net/%7Ehheffner/DeflationFusion2.pdf

The use of a high frequency high voltage AC field, possibly via resonant microwave cavities, or maser or laser stimulation, applied to such material as discussed above, has the added advantage of generating polarons, and large electron surface flux, and thus increased population density of the deflated state hydrogen. The Letts-Cravens effect, increased activity in the presence of laser stimulation in magnetic field, is an indication this approach has some prospect of success. See: Cravens, D. and D. Letts. 2003, "Practical Techniques In CF Research - Triggering Methods",Tenth International Conference on Cold Fusion, Cambridge, MA:

http://www.lenr-canr.org/acrobat/CravensDpracticalt.pdf

Magnetism, especially magnetic *gradient* induced tunneling of neutral particles with high magnetic moments, is key to LENR. It is notable that this has been a key difference between deflation fusion theory and Widom and Larsen theory. If an electron has a weak reaction with a proton, creating a slow neutron, prior to its fusion with a heavy nucleus, then the 3 orders of magnitude larger electron magnetic moment is lost. The massive magnetic gradients permitting tunneling into lattice element nuclei is lost. The reactions themselves, and their products, can be expected to have massive and in some cases long lasting signatures. No energy deficit is brought to the composite nucleus, as it is with deflation fusion. No prospect exists for follow-on weak reactions because the electron no longer exists.

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Magnetism is the key. Magnetic orbitals at nuclear radii or less are key. This theme runs throughout deflation fusion theory.

PROBABILITY OF DEFLATED STATE

Using the point-sphere coupling formula:

psi_100(r) = 1/sqrt[Pi*a)^3])*Exp[-r/a)]

from Fig. 1 of:

http://vixra.org/pdf/0902.0005v1.pdf

where a = 52.9 pm, we integrate to obtain P(x) at radius x:

P(x) = integral[r=0 to x] ((1/sqrt[Pi*a)^3])*Exp[-r/a)])^2*4*Pi*r^2

P(x) = integral[r=0 to x] ((1/sqrt[Pi*(5.29e-11)^3])*Exp[-r/(5.29e-11)])^2*4*Pi*r^2

P(x) = (-1) - (-1 + (-0.591767 - 0.17509*x)*x)/Exp[0.591767*x]

Given Exp[0.591767*x] ~= 1 for x small, we have:

P(x) = (0.5918 + 0.17509*x)*x

P(x) = 0.5918 x + 0.17509*x^2

With correct units:

P(x) = (0.5918 m^-1) x + (0.17509 m^-2) *x^2

However, for x small, we also have 0.17509*x^2 ~=0, so,

P(x) = (0.5918 m^-1) x, for radius x small

Now to consider magnetic binding consequences.

In a small state electron-deuteron pair separated at radius r the electrostatic potential Ue is:

Ue = -2*(1/4*Pi*e0)*q*q/r

The magnetic potential Um is:

Um = -mu0*muD*muB/(2*Pi0*r^3)

The total EM potential Ut is thus:

Ut = [-2*(1/(4*Pi*e0))*q*q]/r + [-mu0*muD*muB/(2*Pi)]/r^3 = A/r + B/r^3

Where:

e0 = 8.85419x10^-12 F/m
q = 1.602177x10^-19 coul
mu0 = 1.25664x10^-6 A m^2
muB = 9.27402x10^-24 A m^2
muD = 4.33074x10^-27 A m^2
muP = 1.41061x10^-26 A m^2

A = -4.61416x10^-28 J m
B = -8.03267x10^-57 J m^3

The radius were magnetic binding potential energy loss equals Coulomb binding potential energy loss for deuteron is:

A/r = B/r^3

r = (B/A)^(1/2) = 4.172x10^-15 m

r = 4.172 fm

For the proton, B=2.61640x10^-56 and

$r = 7.53$ fm

From this precursor state the orbital should rapidly decay into a magnetic force bound orbital similar to that described here:

http://www.mtaonline.net/~hheffner/FusionSpreadDualRel.pdf

In an ordinary deuterium atom in a vacuum the probability of the precursor state is approximately:

$P(x) = (0.591767\ m^{-1})\ x$

$P(x) = (0.591767\ m^{-1}) * (4.172x10^{-15}\ m)$

$P(x) = 2.469x10^{-15}$

However, the time in this state is greatly increased in duration, due to the magnetic trapping of the electron, thus its observed probability is increased. Also, the trapping time may be affected by field conditions in the lattice. It is also notable that the tipping point for slipping into the principally magnetic orbital may occur at a larger radius than the 50/50 B/E potential energy point.

Using a hydrogen orbital frequency of 6.57x10^15 Hz, there is about (2.469x10^-15) * (6.57x10^15) = 16 close passes per second in ordinary hydrogen atom. If each close pass results in a deflated state of only 1 attosecond, then hydrogen spends only 16 attoseconds per second in the deflated state. Given a similar rate in H2 we can see why ordinary molecular hydrogen does not fuse, because the hopping rate would have to be astronomical to support an observable fusion rate. However, hydrogen absorbed into a lattice is not molecular hydrogen, and does not have only 16 close passes of the electron per second. Absorbed hydrogen nuclei do not have ordinary orbitals, but are bathed in an electron current. This is especially true if an in-lattice electric field displaces the hydrogen nucleus away from the central low potential lattice site into the electron cloud of adjacent heavy lattice atoms. It is also increasingly true if powerful EM fields create deep plunging Rydberg type "orbitals" for the pass-through electrons.

If every electron pass is a close pass, and the pass rate is still anywhere near 6.57x10^15 Hz, the time spent in the deflated state is near (6.57x10^15 Hz)*(1x10^-18 s) = 6.57x10^-3, or about 0.66 percent of the time. If the electron flux becomes intense enough, due to the large number of candidate electrons (not just the single orbital electron) then the hydrogen nucleus can spend the majority of its time in the deflated state. This is one of the reasons why design of in-lattice fields and currents is so important.

STRONG REACTION PRECEDES WEAK REACTIONS

Except for purely strange matter reactions, the initial (post hydrogen tunneling) nuclear fusion reaction is almost always strong force based. The electron trapped in the new composite nucleus provides the opportunity for a very fast follow-on weak reaction, provided the energy is available for that to happen. The trapped electron post strong force reaction is not near the nucleus, it is inside of it. The electron only expands its orbital to reach a stable atomic orbital if a weak reaction does not quickly follow the strong reaction. This orbital expansion is driven by zero point energy. The proximity of the electron to the hydrogen nucleus, and its high kinetic energy and mass, prior to tunneling into a heavy nucleus, are for practical purposes random variables. The resulting associated values post tunneling are thus also random variables. The energy balance for individual LENR reactions are therefore also random variables. Energy does not appear to be conserved, because vacuum energy transactions are involved. Time of electron near the nucleus is a random variable, and one which, along with the other random variables, affect the branching ratios.

THE MYSTERY OF 2 H, 4 H AND 6 H TRANSMUTATIONS

One of the mysteries of deuterium cold fusion transmutation is why 1, 2, 4, or 6 atoms are added to the lattice elements. (See Storms, The Science of Low Energy Nuclear Reaction, p. 175) There are also mysteries regarding the apparent preference of pair-wise proton additions to heavy nuclei, as discussed above in relation to Ni + 2 p. Deflation fusion provides some answers in this regard.

Following are some isotopes commonly involved in LENR transmutation experiments and their nuclear magnetic moments:

47TI -0.78848

49Ti -1.10417
57Fe +0.0906
57Fe +0.0906
59Co +4.63
61Ni -.75002
87Sr -1.09360
91Zr -1.30362
105Pd -0.642
107Ag -0.11357
109Ag -0.13056
133Cs +2.582
135Ba +0.838
137Ba +0.9374
195Pt +0.6095
197Au +0.14575

The remaining common isotopes of these elements, namely
84Sr, 86Sr, 88Sr, 46Ti, 48TI, 50Ti, 54Fe, 58Fe, 59Fe, 58Ni, 60Ni, 62Ni, 64Ni, 84Sr, 86Sr, 88Sr, 90Zr, 92Zr, 94Zr, 96Zr, 102Pd, 104Pd, 106Pd, 108Pd, 110Pd, 130Ba, 132 Ba, 134Ba, 136Ba , 138Ba, 190Pt, 192Pt, 194Pt, 196Pt and 198Pt, have zero magnetic moments. It is notable that the radioactive isotopes of these elements tend to have nonzero nuclear magnetic moments. This increases their chances of attracting a deflated hydrogen, and thus transmuting into a stable isotope.

Nuclear magnetic moments are expressed in units of the nuclear magneton, mu_N, where:

mu_N = e h_bar/(2 m_p) = 5.05078324x10^-27 J/T

In contrast to the above heavy nucleus nuclear magnetic moments, the magnetic moment of the electron, in terms of mu_N is 1836.1528, about 3 orders of magnitude larger.

Elements with positive magnetic moments have nuclear magnetic moments aligned with their spins, as do protons. Elements with negative magnetic moments have nuclear magnetic moments opposed to their spins, as do neutrons.

It is common sense that tunneling of deflated hydrogen, with its large magnetic moment, due to its included electron, into a nucleus having a nuclear magnetic moment is energetically feasible due to magnetic attraction. What is of more interest is the involvement of isotopes with zero magnetic moment in heavy element transmutation.

It is proposed above that electrons of heavy nuclei occasionally enter those nuclei, thus providing a large brief nuclear magnetic moment, and thus triggering tunneling of deflated hydrogen into the nucleus. The initial electron, having a large kinetic energy, can be expected to quickly depart during the ensuing process, leaving only the lower energy trapped electron behind. This leaves the nucleus with a prolonged large magnetic moment. Any deflated state hydrogen in the vicinity should quickly also tunnel in. However, here the process most likely stops. The trapped electron spins are most likely, but not necessarily, co-aligned as opposed. Their spins are with high probability co-aligned as spin up and spin down, thus canceling magnetic fields, but have some probability of co-aligned spins in the same direction. In the latter case, the nuclear magnetic moment doubles and a follow-on addition of another pair becomes likely. This process can repeat. This tendency provides some degree of explanation for the mysterious tendency for 2H, 4H, and 6H transmutations, where none exists otherwise in published theories, as noted by Storms. Here "H" means any isotope of hydrogen.

"LATTICE" VS "MESH"

Throughout this paper the term "lattice" has been used to describe the structure of atoms of condensed matter which act to adsorb, absorb, and catalyze the fusion of hydrogen and heavy nuclei. Given that the critical catalytic structures likely involve mixes of materials, interfacial surfaces, atomic defects, and possibly metallic glasses and amorphous materials, the word "mesh" would be more appropriately applied in place of lattice, though the word "lattice" is commonly used in the literature, even in these special cases.

DEFLATION FUSION VS WIDOM & LARSEN THEORY

The deflated state requires no preliminary weak reaction. Such a reaction would produce a neutron. This is the opposite of what is suggested, because neutrons can not explain the energy deficits of heavy LENR, neutrons activate heavy nuclei, neutrons can not explain the unusual branching ratios, cluster fusion, etc. etc. etc.

The deflated hydrogen state is explicitly stated to exist for attosecond order durations, but, where LENR occurs to any observable degree, the state is repeated with a high frequency so as to make the state sufficiently probable, and the lattice half life of the hydrogen appropriate.

DEFLATION FUSION VS VIRTUAL NEUTRON THEORIES

Virtual neutron related theories have been proposed by Yang, Hagelstein and others. Deflation fusion differs from these theories in that the deflated state is not a virtual state, it is not Heisenberg limited, even though the kinetic mass of the electron and associated hydrogen nucleus significantly increases.

DEFLATION FUSION VS HYDRINO THEORY

The main difference between the deflated state and Mill's hydrino is that the deflated state is primarily magnetically bound, and thus a much smaller state.

Mill's hydrino also requires no weak reaction to form. It requires a catalyst molecule or ion or atom which can remove the precise amount of energy required to form a fractional quantum state orbital. This is necessary because fractional state changes in Mill's theory do not involve radiating photons. The radii of Mill's hydrinos are huge compared to the dimensions of deflated hydrogen. The deflated hydrogen state requires no photon emission or other energy transaction to form. The deflated state is thus a degenerate state of the hydrogen within its environment. The fusion tunneling probability is raised in Mill's theory by the reduced hydrogen atom radius. The fusion probability in deflation fusion is raised by the vastly increased combined *ensemble* tunneling probability of the hydrogen-nucleus-electron pair, which retains at all times a low Coulomb binding energy, and its very small size.

Deflation fusion is not initially a weak force reaction. What it is suggested to do is create a highly de-energized nucleus via a strong force reaction, this de-energized nucleus has trapped within it an electron. An electron energetically trapped within a nucleus provides the possibility of a very short half-life weak reaction. Numerous prospective strong force only heavy LENR reactions here:

http://www.mtaonline.net/~hheffner/dfRpt

along with an approximation (in brackets) of the resulting energy deficit based on the composite nucleus radius. To look at weak reaction prospects it is only necessary to assume a weak reaction follows and then compute the product masses and energies involved.

DEFLATION FUSION AND MIRROR MATTER

It has been proposed that mirror matter has a negative gravitational charge. See:

http://www.mtaonline.net/~hheffner/CosmicSearch.pdf

http://www.mtaonline.net/~hheffner/GravityPairs.pdf

This is of some relevance with regard to LENR. If LENR can create low mass neutral particles, like K0 kaons, then there is a possibility it can create long lasting mirror matter. This can happen directly, or via neutral particle oscillation. Small neutral particles like K0 kaons can oscillate state, like neutrinos. If the oscillations include mirror symmetry, then mirror particles could be created before kaon disintegration or absorption. Mirror particles can weakly couple to ordinary matter nuclei. Anti-gravitational mirror matter could be manufactured by LENR. Mirror matter radiates mirror photons which travel through ordinary matter unimpeded. There is no means to insulate mirror matter, so it causes matter to which it is coupled to spontaneously cool. If enough mirror matter is created, and bound by the very small mirror matter coupling constant, it can be detected by this thermal property. For a sample experiment see:

http://www.mtaonline.net/~hheffner/Mirror4

ORBITAL STRESSING

The probability of the deflated electron state is increased as electron flux through or very near a hydrogen nucleus is increased. This kind of electron flux can be induced on an absorbed hydrogen via various mechanisms, such as directly applied currents, flux of conduction band electrons through partial orbitals, surface currents, EM induced conduction ring currents, such as that provided by a benzene ring, or magnetic vortices in magnetic materials. The deflated state of heavy nucleus components can be induced by dense electron flux, but the above methods can not conveniently do this. Creation of a heavy nucleus deflated state, and thus the increase of its nuclear magnetic moment by orders of magnitude, is important to nuclear reactions involving heavy nuclei without nuclear magnetic moments, such as various Ni nuclei.

The primary way to induce large electron flux through a heavy nucleus is to displace it from its atomic center of charge. The electron flux then involved is that of the heavy atom itself, consisting primarily of the innermost and thus most energetic of its electrons. This displacement can be induced by imposition of EM fields, and other means of orbital stressing, such as raising temperature or increasing lattice stress by loading and then thermal cycling. The methods, value and potential uses of orbital stressing to place nuclei into a strong electron flux were discussed in this 1997 article:

http://mtaonline.net/~hheffner/Ostressing.pdf

As discussed in this article, lattice nuclei are confined in linked electron cages. Since the nuclei are over 1000 times heavier than the electrons, the electron cages are, for the most part, going to move around the nuclei as a single lattice unit. The nucleons will not be involved in most of the motion. Thus the amount of mass involved in actual motion is small, three orders of magnitude less than the entire lattice mass, which is good for creating higher speed action. The hard part, it seems, is keeping the lattice electron motion uniform throughout the sample, thus avoiding heat loss. Coherent, or nearly coherent motion of the electron cages can slowly induce periodic motion of the nuclei.

The electron cages of nanoparticles are small. They are thus more subject to coherent motion when stimulated electro-magnetically than large lattices. Brief moments of electromagnetic stimulation can create coherent cage motion, followed by increased nucleus motions and thus degeneration of the coherent cage motion into coordinated opposed nuclear motions, and then the randomization into heat. Throughout the process, the nuclei are dislocated from their centers of charge, and thus exposed to higher than normal through-nucleus electron flux. The initial coordinated electron cage motion should be most easily generated in nano-particles.

Their small size permits small and thus energetic EM wavelengths to be effective. Isolating metal nanoparticles in dielectric pore arrays should provide a means to coordinate the stimulation via localized resonances. Conveniently, such coordinated electron cage motion also increases the population of the deflated state of hydrogen simultaneously.

Electrical isolation of conducting nanoparticles in dielectric arrays permits large displacements of nuclei within the nanoparticles via use of large electrostatic fields. The use of nanoparticles permits a large surface to volume exposure, and thus a large voltage differential across a volume of interest. A surface effect is thereby converted into a volume effect, at least to some depth. The addition of the AC stimulation then is additive to this electrostatic field stress.

The discussed methods of orbital stressing should be useful in improving fusion rates in any lattice with absorbed hydrogen.

WHERE KINETIC ENERGY GOES

When multiple particles are produced, purely photon producing channels are greatly diminished in probability, and a nuclear reaction splits the momentum across the products according to mass. When a nuclear electron (or more) is present, there are always at least two product particles. The trapped electron thus avoids much energy going into fast gammas. It does so without even being released as a beta if the energy deficit number (in brackets) is negative. Neutral particles, like a neutrino, can carry off most of the prompt energy right away, especialy a neutrino due to the low neutrino rest mass. A trapped electron takes time to radiate energy. If a weak reaction takes place quickly, that time is not available.

KINETICS OF TRAPPED ELECTRONS

The weak force has an interaction range limited by the lifetime of the messenger particles, the W bosons, about 10^{-18} m. Using $r = 2 * (1.25\text{E-}15\ \text{m}) * A^{(1/3)}$, for 59Ni we have $r \approx 4.87 \times 10^{-15}$ m. The relativistic trapped electron passes through a cloud of 118 up quarks to cross the diameter of the nucleus of 59Ni in about 3×10^{-23} seconds. A trapped relativistic electron in effect traverses the nucleus at an initial rate of about 30,000 times per attosecond. Electrons are not affected by the strong or color forces. They are affected by quark charges and magnetic fields however, so their paths should be eventually thermalized. In that process they can cool reduce kinetic energy and then cool the nucleus via emission of many photons.

WEAK REACTION CROSS SECTION

Assuming the electron is a point and the cross section of the up quark is Pi*(10^-18 m)^2 = 3x10^-36 m^2, and the nuclear density of the up quarks is 118/((4/3)*Pi*(4.87 x 10^-15 m)^3) = 2.4x10^44/m^3, we have a mean free path L of:

L = 1/((2.4x10^44/m^3)*(3x10^-36 m^2)) = 1.39 x 10^-9 m

and a mean weak reaction time of about 5x10^-18 seconds, about 5 attoseconds. These values are reduced by the presence of vacuum fluctuation strange quark pairs. The half-life of such pairs is extended by the electrostatic fields reszulting from electron(s) in the nucleus.

ENERGIES OF DEFLATED STATE VS TRAPPED STATE

To understand the energy dynamics you have to distinguish between the deflated hydrogen state prior to tunneling to the nucleus via wavefunction collapse, and the state of the deflated hydrogen immediately following that tunneling, which involves the trapped electron state. The electron is trapped not by the hydrogen nucleus, but by the composite nucleus.

The combined kinetic plus mass plus potential energy goes nowhere when the electron deflates, remains unchanged. The deflated state is a degenerate state. There is no energy exchange involved in the transition between the deflated state and the normal chemical state of the hydrogen. There are no x-rays emitted. There are also no photons emitted from the tunneling process itself because it is a neutral entity tunneling. However, once the tunneling process is complete, the electrons are trapped. The joint field energy between the electron and target nucleus, such energy being vacuum resident, is depleted. The joint field energy between the the hydrogen's proton and the target nucleus, which is also vacuum resident, is increased by an amount equal to the loss of the joint target nucleus electron field energy. However, the vacuum field energy gained by the proton's fusion is locked into place via the strong force - unless a fission can occur, such as an alpha emission. No means exists for the nuclear potential to immediately transfer energy to photons from the tunneling process. The field adjustment for the energy deficit from the electrons is transmitted throughout the nucleus at light speed. It is especially notable that the potential energy stored up via the proton's EM field may eventually result in mass increase of the nucleus, once the electron departs, but does not result immediately in either a mass increase or released kinetic energy which can be converted into EM energy or trigger a fission, because the field energy of the proton is negated by the field energy of the electron by superposition.

The electron capture energy further subtracts from the energy deficit by in effect taking it from the trapped electron's kinetic energy. Ultimately, I think a net energy deficit from a fast electron capture reaction is made up by nuclear heat, i.e. zero point energy. There are various heavy element transmutation reactions that have been observed without enthalpy corresponding to nuclear mass changes, and without high energy signatures. Only the energy deficit of the trapped electron can explain this. Some enthalpy may occur due to the photon radiation that occurs due to interaction of the trapped electron with the nucleus, but a weak reaction cuts this process short.

ENTHALPY FREE REACTIONS

A heavy element transmutation can in theory produce no enthalpy or nuclear signatures at all. Consider Kervan's chickens.

The work of Corentin Louis Kervan:

http://en.wikipedia.org/wiki/Corentin_Louis_Kervran

indicates biologically induced transmutations occur in nature, and in chickens in particular in calcium deprived environments. If true, this is a beautiful example of the energy deficit, the violations of conservation of energy, that accompany many forms of heavy element LENR.

The fact an egg a day per chicken is produced not only permits calculation of the nuclear energy involved, but also the nuclear power which should be produced. A typical egg shell has 750-800 mg of calcium. In a calcium deprived environment the egg shells are thin, so we might assume only 200 mg Ca per egg. The reaction suggested is:

39K19 + p* --> 40Ca20 + 8.328 MeV

but could possibly be some of the following:

39K19 + 2 p* --> 40Ca20 + 1H1 + 8.328 MeV [-5.035 MeV] (B_K:3)
40K19 + 2 p* --> 40Ca20 + 2H1 + 2.753 MeV [-10.503 MeV] (B_K:4)
41K19 + 2 p* --> 42Ca20 + 1H1 + 10.277 MeV [-2.876 MeV] (B_K:12)

where p* is a deflated proton-electron ensemble. The reaction

39K19 + p* --> 40Ca20 + 8.328 MeV [1.928 MeV]

very notably does not have a clear initial energy deficit, unlike

39K19 + p* --> 36Ar18 + 4He2 + 1.289 MeV [-5.112 MeV]

which leaves no calcium. The proposed reaction 39K19 + p* --> 40Ca20 would be feasible with no energy generation if the additional energy deficit due to deflated quark, as opposed to a deflated proton is taken into account. An initial two proton hypothesis looks more sensible here, but the energy deficits have to be recalculated for that.

Now to look at the chicken's conventionally expected fate.

The atomic weight of Ca is 40.078 g/mol, so the energy E produced per gram of Ca produced, by conventional physics is:

E = (1/(46.078 g/mol)) * N_avrogadro * 8.328 MeV = 4844 kWh

and the energy E_egg produced per egg, by conventional physics is:

E_egg = (4844 kWh/g) * (0.2 g) = 969 kWh

The power P to produce this much energy, and the power the chicken must dissipate to stay alive is given by dividing by 24 hours:

P = (969 kWh) / (24 h) = 40.4 kW

This is similar to the power of 40 microwave ovens converged on the chicken. Fully cooked in seconds. Crispy! If this does not kill the chicken then the radiation damage should.

If there is anything at all to biological transmutation, then conventional physics involving no electron in the newly fused nucleus, thus de-energizing it, provides no explanation of the results. Deflation fusion theory:

http://www.mtaonline.net/~hheffner/CFnuclearReactions.pdf

can account for the live chickens.

The nearby lattice, or even a catalytic lattice or molecule, absorbing all the nuclear energy from this kind of heavy LENR (and many others better documented) can clearly not be used as an explanation for this phenomenon, the lack of heat. The missing heat still needs an explanation that lattices can not satisfy.

MISSING REACTION SIGNATURES AND ENTHALPY

Following is a spreadsheet that can give an idea of the huge amounts of energy that should be involved in various Pd or other cluster fusion reactions that have been observed:

http://www.mtaonline.net/~hheffner/PdFusion.pdf

The Iwamura et al experiments observed transmutations Cs-->Pr, Sr-->Mo, and Ba --> Sm in a 100 angstrom transmutation zone. Quantities sufficient for X-Ray Fluorescence spectrometry were created. See:

http://www.lenr-canr.org/acrobat/IwamuraYobservatiob.pdf

Clearly such experiments should be carried out for longer periods, using larger quantities, and enthalpy balances should be obtained with sufficient accuracy to determine if conservation of energy (COE) is being violated. If a violation of COE is confirmed, this is obviously an important scientific discovery. My theory predicts this violation of COE will be found.

Whether this 100 angstrom zone Iwamura et al identified is a lattice or more like a ceramic glass I think is an interesting question. Similarly, codeposited films in various experiments, such as SPAWAR's, which involve open cells and thus undoubtedly do not involve high degrees of purity, may be highly imperfect lattices at best.

EXISTENCE OF AN NAE

In regards to other non-lattice LENR possibilities, there are very few LENR experiments where the nuclear active environment (NAE)is proven physically to actually be a lattice. The NAE is often destroyed, so such proof in those cases is impossible. Proof of the nature of the NAE requires a comprehensive a priori assay of the material. I suggested that this might in fact be feasible to some extent, by building surface arrays of nano-pores (e.g by anodizing aluminum) and loading the pores by co-deposition. If small arrays are used, it is possible to pre-assay each cell to see if anomalies might be identified that later cause nuclear reactions.

Use of extremely pure materials, even very pure Pd crystals, has not proved successful in producing a level of energy production that could even be considered an indication of the feasibility of commercial application. Impurities seem to be key, as do nano-structures. It has to be asked if perfect lattices are actually an impediment to the nuclear catalysis. In fact, it is reasonable to ask if perhaps all energy producing NAEs are non-lattices? Perhaps the surrounding lattice material could be replaced with disordered glass to the same effect. So little is known with certainty, and generally agreed upon, experimentally supported, regarding NAEs, that it is not possible to say with certainty that lattices are required or even catalytically involved at all.

Until perfect models of the various forms of nuclear catalysis are formed, the random nature of glasses and highly imperfect, non-lattice, surface films may be of great use in increasing the reliability, the repeatability, of experiments. Such repeatability may be of use in developing useful models, and even lead to commercial processes.

REVIEW OF DEFLATION FUSION STATES

The Rossi Ni + p Byproduct Riddle

Horace Heffner December, 2011

In review, here I'll treat the heavy atom transmutation deflation fusion as a process (which it may actually not be) and break it down into the most simple steps possible, assuming there is a net energy deficit created in the process.

1. A small hydrogen state, with ordinary chemical energy, call it the deflated state, precedes subsequent steps. Such a state exists periodically in ordinary hydrogen containing molecules, because even the Schrödinger equation, with its limitations in the regard to relativistic states, magnetic binding, or mutually orbiting heavy electrons and nuclei, predicts the electron to be close enough to the nucleus on occasion. My theory shows the duration of this close proximity can be extended due to magnetic dipole attraction, external electric fields, and relativistic effects, without net energy changes. The probability of this state is increased by bathing absorbed hydrogen in electron currents by various proposed means.

2. The neutral small hydrogen, the deflated hydrogen, tunnels into an adjacent lattice nucleus. The neutral charge eliminates the tunneling barrier, thus greatly increases the hopping rate into the nearby atom over the ordinary hopping rate between the much more separated lattice sites. The size and other physical parameters of the deflated hydrogen state are unaffected by the tunneling process itself. No radiation occurs as a result of the neutral particle ensemble tunneling.

3. The strong force binds the proton. The electron is trapped because it still has a small kinetic energy, but now has a huge negative potential energy. In the case of Ni the electron suddenly has 29 times less potential energy than it did in the pre-fusion deflated sate, because it is attracted to a nucleus that now, instead of containing a single positive charge, contains the 28 Ni protons plus the deflated hydrogen proton.

4. The trapped electron moves about in or very near the nucleus, radiating photons.

5. The trapped electron is either involved in a very fast electron capture, or its kinetic energy drained away sufficiently, i.e. its wavelength is expanded sufficiently by zero point energy, to occupy an orbital, generating auger effects, or it is involved with virtual strange quark pairs.

A quick review:

1. Deflated state hydrogen

2. Tunneling state

3. Initial trapped electron state, fused nucleus state

4. Electron radiating state

5. Final state: auger orbital, electron capture by up quark, or strange reaction

This 5 step process is non-reversible because the strong force prevents a reversal. There is no way to go back to state 2 from state 3. The field energy of the fused, heavy nucleus bound, proton is negated by superposition with the trapped electron. The binding energy of the electron has increased by a factor of 29, while the kinetic energy it brings to the transaction remains fixed. The *initial* net energy deficit is then equal to the fusion energy plus the electron energy deficit. The net energy in state 3 is the net energy I show in brackets in the reaction equations in my reports.

RELATIONSHIP OF DEFLATION FUSION TO PLASMON RESONANCES

The hydrogen deflated state is increased in probability by a large electron flux through hydrogen absorbed in an atomic lattice (mesh), by high electron fugacity and large surface potentials, conditions that occur in a resonant plasmon state, especially in nanoparticles. Tunneling of deflated state hydrogen into adjacent nuclei is increased in probability by large magnetic fields, due to a priori spin coupling, and by the energy advantage provided by large magnetic gradients. As noted on page above this tunneling of deflated state hydrogen into heavy nuclei can result in pure zero point energy extraction, which results in an EM pulse consisting of a positive wave, due to protons escaping, followed by a negative wave due to electron orbital expansion fueled by zero point energy. It can also result in a multiple radiant pulses of electron fueled photon generation post strong force fusion, due to resonant motion of trapped electrons back and forth through the nuclei with which they are trapped, and made feasible via spin flipping when in the nucleus.

The resulting nucleus based electromagnetic energy pulses can occur in femtoseconds, and are thus capable of synchronizing with a well tuned stimulating frequency, producing the possibility of direct electrical energy extraction. This effect is proportional to the product of the probability of the deflated state forming in a given oscillation times the probability of heavy nucleus tunneling of the deflated hydrogen within a cycle, and this combined effect needs to be optimized by choice of plasmon frequency, lattice (mesh) spacings, temperature, hydrogen loading, fixed external fields, etc.

SUMMARY

Two assumptions regarding Ni + p, assumptions with some degree of logical foundation, given the application of deflation fusion theory, can explain the lack of radioactive byproducts from Ni + p reactions. These assumptions also result in potentially useful predictions. The most important predictions are the potential improvements to reaction rates that can be provided by use of magnetic fields and high mu fusion catalysis material, such as mu metal. Also, the use of Ni highly enriched in 62Ni and 64N is implied to improve energy density. In 62Ni and 64Ni only production of Zn is predicted to be highly correlated with excess enthalpy production. Finally, the use of high frequency high voltage stimulation of hydrogen loaded metal imbedded as insulated nanoparticles in dielectric nanopore material, or as nanoclusters in amorphous material with similar metallic island insulating properties, is indicated as a method to achieve a high active surface density.

Some of these implications clearly apply to protium or deuterium LENR in other media as well.

This is a tenuous theory, but one with readily testable predictions and potentially useful applications.