CAN WE AVOID PENETRATING RADIATION?

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WHAT KIND OF RADIATION IS PENETRATING?

Alphas and betas are charged paricles and are stopped by trivial barriers.

Neutrons and photons are neutral and can penetrate substantial shielding.

Any theoretical model needs to explain not just chosen results but also the absence of expected penetrating radiation.

Why don’t we see lethal neutrons and gammas?

WHAT WE DON'T SEE (1)

Bockris, Claytor, Srinivasan, Storms and others have detected tritium using scintillation counting and autoradiography mainly in deuterated systems.

Where are the 14.1 MeV fast neutrons expected from:-

$$^{2}H + {}^{3}H \rightarrow n + {}^{4}He + 17.589 \text{ MeV ?}$$

Frequent solution: The tritons have less than 10 keV energy

This is a major constraint (1) on any theory!

WHAT ELSE WE DON'T SEE (2)

If there is any Coulomb Barrier, we expect low mass (and low charge) nucleons to penetrate it more easily. Consequently a reaction such as

^{2}H + p -> ^{3}He +5.493 MeV

should be orders of magnitude more probable than

^{2}H + ^{2}H -> ^{4}He +23.847 MeV

We not detect vast excesses of ^{3}He compared to ^{4}He

Frequent solution: There is no Coulomb barrier in LENR!

This is a major constraint (2) on any theory!

HOW SOME REAL THEORIES ADDRESS THE CONTRAINTS

1. The Widom Larsen theory

2. The Deep Dirac Level (DDL) model of Paillet of Meulenberg

3. The Exotic Neutral Particle (ENP) models of Bazhutov and Fisher

WIDOM LARSEN

- **Electrons are conjectured to acquire energy.**
- **Sufficiently heavy electrons can be captured by protons to create neutrons.**
- **Neutral neutrons can be captured without any Coulomb Barrier. Overcoming constraint (2)**
- **No explanation for lack of 14.1 MeV neutrons**
- **Ad hoc explanation for shielding of gammas by heavy electrons.**

PROBLEMS WITH WIDOM LARSEN THEORY

- **Heavy electrons will be captured by natural elements other than hydrogen too! Indeed these may be the only enrgetically possible captures if the acquired energy is less than 780 keV.**
- **There are 65 naturally occurring isotopes which become beta radioactive on capturing a 780 keV electron. Where are they?**
- **Example: e- + ^{3}He-> ^{3}H + . -0.019 MeV**

  (but we make tritium at low kinetic energy!!)

AD HOC HEAVY ELECTRON SHIELDING?

- **If this ultra efficient shielding exists it has never been demonstrated experimentally**
- **Even if it exists, some neutrons will penetrate the shield and activate cell components**
- **An unsatisfactory explanation for lack of gammas and residual radio-activity even with optimistic assumptions.**

THE DEEP DIRAC LEVEL (DDL) MODEL OF PAILLET OF MEULENBERG

- Isotopic hydrogen collapses to femto atom size
- It is chemically inert H# D#
- It is almost neutral and can approach other charged nuclei
- A nuclear reaction can then take place
- The energy of the reaction is carried off by the close DDL electron instead of by a gamma.

This looks like a good effort to explain both constraints. ☺

More verification is in order….

WHAT KIND OF REACTIONS ARE POSSIBLE WITH H# ?

Let's look at a reasonable subset of enhanced proton capture reactions of the form:-

$$H\# + {}^{A}E_{Z} \rightarrow {}^{A+1}E_{Z+1} + e^-$$

Are there any isotopes typically present in light hydrogen systems which are expected to become radio-actively activated?

PROTON ACTIVATIONS

Proton capture often leads to positron emitting products such as:-

H# + ^{16}O -> ^{17}F + e- +0.600 MeV

H# + ^{17}O -> ^{18}F + e- +5.607 MeV

H# + ^{58}Ni -> ^{59}Cu + e- +3.419 MeV

H# + ^{102}Pd -> ^{103}Ag + e- +4.158 MeV

H# + ^{104}Pd -> ^{105}Ag + e- +4.965 MeV

H# + ^{105}Pd -> ^{106}Ag + e- +5.813 MeV

Systems usually contain oxygen, nickel or palladium.

Where are the expected residual anhilation gammas?

WHERE ARE THE EXPECTED RESIDUAL ANHILATION GAMMAS?

Andrew Meulenburg comments:-

The direct weak interaction, e.g., H# + 16O -> 17O is preferred.

•The energy of the weak interaction is radiated away by the close DDL electron during the interaction instead of emitted in a gamma.

• The emitted neutrino would be low energy also.

My comment:-

Weak and strong reactions occur at rates which differ by 20+ orders of magnitude!

THE EXCEPTION.
(BY MEULENBURG)

H# +^{102}Pd → ^{103}Ag # ... - β+ → ^{103}Pd # ... - β+ → 103 Rh

Because of the double (sequential) positron decay , the second weak interaction cannot be activated by a single DDL electron.

However, ^{102}Pd is only 1% of the Pd content, so the amount of 511 keV radiation from the ^{103}Pd # ... - β+ → ^{103}Rh reaction would not be large in the PdH fusion process.

Furthermore, the normal reaction is the D+D => ^{4}He, so the amount of H available for the reaction is reduced much further. The predicted ^{102}Pd + D# -> ^{104}Pd or ^{102}Pd + ^{4}He## -> ^{106}Pd reactions would not have the problem

The DDL electron can either carry away the energy and suppress gamma(s) OR it can get captured, but not both!

WHY DO WE EXPECT RESIDUAL RADIO-ACTIVITY?

- **Proton, neutron and deuteron capture are energetic.**
- **If we supply too much energy to even a stable isotope it is probable that the product will be unstable.**
- **Most unstable products also produce gamma radiation (but many exceptions are known)**

SOME STATISTICS

There are some 287 naturally occuring isotopes on this planet. When interacting with low energy neutrons, protons, deuterons, ENPs, how many spin and parity conserving reactions leave residual radio-activity?

Entity	Number of beta radio-active products	
Neutron	23 capture reactions	
Proton (H#)	24 capture reactions	
Deuteron (D#)	46 capture reactions	
€0 (Erzion)	0 neutron transfer	
€N	2 neutron transfer	(^{36}Cl & ^{86}Rb)

SO THE ENP THEORY DOESN'T PREDICT MUCH RADIO-ACTIVITY

^{36}Cl – For reasons not clear, chlorine is not often used in an electrolyte (exception Mel Miles' work). ^{36}Cl has a half-life of 301,000 years and < 0.03% decays produce gammas (511 keV). Such a weak signal at a common energy might be overlooked.

^{86}Rb in contrast has a much shorter half life of 18.6 days and 8.64% of decays produce 1.077 MeV gammas – easily detectable.

See poster paper at this workshop of attempt to replicate

Bush R., Eagleton R. Evidence for Electrolytically Induced Transmutation and Radioactivity Correlated with Excess Heat in Electrolytic Cells With Light Water Rubidium Salt Electrolytes, *Proc. ICCF4* **3**, (1993), p 27

www.lenr-canr.org/acrobat/EPRIproceedingb.pdf

ENP & TRITIUM

Both Fisher and Bazhutov have suggested a exceptionally low energy reaction of the form:-

$^{2}\mathrm{H} + Э_{N} \rightarrow {}^{3}\mathrm{H} + Э^{o} + 0.01\ \mathrm{MeV}$

1. **Not a very convincing explanation as we arbitrarily fix the delta mass of the ENP. ☹**
2. **This delta mass fix predicts other radio-active products too.**

CONCLUSIONS

A simple subset of the ENP theories proposed independently by John Fisher and Yuri Bazhutov is remarkably successful in predicting the absence of residual radiation because the reactions predicted are not excessively energetic.

This does not mean that it is correct or complete. But a way forward is suggested.

Details of the ENP subset was presented at ICCF20 and Avignon in 2016. Further experimental and theoretical work is in progress.