POLYNEUTRON THEORY

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Abstract

I suggest that neutron clusters of sufficient size are bound and stable against strong decay; and that they can react with ordinary nuclei by transferring neutrons to them, accepting neutrons from them, and binding with them to form composite nuclei. Implications of this enlarged scope of low energy nuclear physics include a chain reaction with nuclear fuel ^{2}H that produces energy, ^{4}He, ^{3}H, and a wide range of nuclear transmutations. Natural explanations emerge for these and other LENR nuclear phenomena for which evidence has been accumulating over the past two decades.

Polyneutron theory is based on the idea that conventional nuclear theory accounts for all LENR phenomena.

Low energy nuclear reactions require neutral particles. We are familiar with neutrons, which are responsible for ordinary nuclear reactions. Because neutrons have no electric charge they can approach any nucleus. There is no coulomb barrier. They can react with many different nuclei.

Consider fission of uranium. When a neutron meets and joins a uranium nucleus the nucleus can fission into two nuclei. These nuclei emit two or three neutrons as they settle into their ground states, so one neutron leads to two or three. Each of the two or three causes fission of another uranium nucleus and becomes two or three itself, and so on. We have a chain reaction that builds up to a level where we can get useful power.

But neutrons are not seen in the LENR phenomena that we study. We need another kind of neutral particle and it must be something to which conventional nuclear physics applies. What could it be?

One possibility is neutron clusters, or polyneutrons. These are isotopes of the neutron. Their existence enlarges the table of isotopes. If we knew the masses of polyneutrons we could calculate which polyneutron reactions would be exothermic, how much energy they would produce, and what products they would produce. Now the questions become: How can we determine if polyneutrons actually exist? How can we determine their masses?

I suggest this can be done the same way we determined that neutrons actually exist. Nobody has ever seen a neutron. The approach was to hypothesize a neutron: its mass, its spin, its magnetic moment; then to use the hypothesis to try to understand experiments; to try to deduce the properties that a neutron would need to have in order to explain the experiments; and finally to become confident that the idea of a neutron having these properties was a good idea, and that it made sense to accept that neutrons really do exist. That's how we came to accept neutrons.

For polyneutrons the same approach applies. We hypothesize that polyneutrons exist. We use this hypothesis to try to understand experiments, to try to deduce the properties that polyneutrons must have in order to explain the experiments, and finally to become confident that the idea of polyneutrons is a good idea and that it makes sense to accept that polyneutrons really do exist. [Of course it may be that this effort will fail, and that the polyneutron idea will be proven wrong and will be discarded. We do not yet know. As yet there are too few experimental results to guide us and the estimates of polyneutron masses are not very accurate.]

But we cannot discard the polyneutron idea just because experiment shows that di-neutrons and tri-neutrons are not bound. A recent experiment at CERN suggests that four neutrons are bound. The binding strength may increase for larger numbers. We have to consider polyneutrons composed of hundreds, or even thousands, of neutrons.

Experiment can place quantitative requirements on polyneutron properties. For example, there must be a chain reaction to build up large numbers of polyneutrons, just as there is a chain reaction to build up the numbers of neutrons in ordinary reactors. Otherwise the energies from polyneutron reactions would be too small.

For neutrons we have the reaction chain neutron → fission of uranium → two or three neutrons, and so on. There is a different path for polyneutrons, beginning with polyneutron growth. A polyneutron absorbs a neutron from a deuterium nucleus, leaving a hydrogen nucleus and a larger polyneutron. (Or it absorbs two neutrons from an oxygen-18 nucleus, leaving an oxygen-16 nucleus and a larger polyneutron.) By many iterations of such incremental growth reactions a polyneutron will grow bigger and bigger. When it is large enough the reaction energy generated in the growth reaction can cause it to fission into two smaller polyneutrons. These then can grow and fission, and so on. We have a polyneutron chain reaction.

This explanation for a polyneutron chain reaction provides a constraint on polyneutron masses. Polyneutron growth is possible only when neutrons are more strongly bound to the polyneutron than to the deuterium and oxygen-18 nuclei from which they come: the masses of the products have to be smaller than the masses of the reactants. This constraint suggests how experiment can begin to assign quantitative values to polyneutron masses.

Other experiments that can further constrain the masses of polyneutrons include observations of helium, of tritium, of Miley and Iwamura transmutations, of energy from electrolysis, of energy from diffusion of deuterium through a palladium film with cadmium oxide under the surface, of an Oriani shower of 150,000 alpha particles in the vapor over an electrolyte, of smaller showers of hundreds of alphas, and of relatively isolated alphas not clearly from showers. It must be possible to assign properties to polyneutrons such that all these phenomena can be explained.

Conversely any reaction that is energetically possible for polyneutrons must be observable. We cannot have implications that are not actually expressed. Consider polyneutron decay as an example. We know that a free neutron transforms into a proton plus an electron plus an antineutrino, with a half-life of about 15 minutes. This is beta decay. We expect that the neutrons in a polyneutron can undergo beta decay, perhaps at a faster rate. In consequence we expect the following series of reactions. First a neutron in a polyneutron decays to a proton. The proton cannot escape the cluster. Its mass as a free particle is too large. It stays bound. Then another neutron beta decays. Now it is energetically favorable for an alpha particle (a helium nucleus composed of two protons and two neutrons) to be emitted. This leaves a new polyneutron with four fewer neutrons. The process repeats over and over:

beta, beta, alpha; beta, beta, alpha; … and so on until the polyneutron is fully transformed to helium.

Hence overall the decay of a polyneutron must be observed as emission of a sequence of alpha particles. If these are rapid and if decay occurs in a vapor a CR39 detector will record a shower of alpha particles. If the emissions are slower the polyneutron may move between alpha emissions and a more nearly random pattern of tracks will be produced. Fortunately for the theory both showers and random patterns have been observed. Polyneutrons pass this test.

Additional experiments are required to determine the energies of the alpha particles and thereby to pin down more closely the required masses of the polyneutrons. So far it seems possible to assign masses that are consistent with experiment. These are approximate masses because the available experiments are insufficient to constrain them more tightly. But it does seem that we are moving toward polyneutron reality. This is only a beginning, but polyneutron theory seems to have survived so far.

I want to emphasize that throughout this work ordinary nuclear theory has been applied. No new fundamental particles are required---just neutrons and protons, recognizing that some nuclei contain no protons. Success of the theory depends on its ability, with these simple assumptions, to universally provide quantification and understanding of all the LENR phenomena. If it cannot do this, or if it predicts phenomena that do not actually occur, it will be proven wrong.