The TGD variant of the model of Widom and Larsen for cold fusion

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Abstract

Widom and Larsen (for articles see the Widom Larsen LENR Theory Portal have proposed atheory of cold fusion (LENR), which claims to predict correctly the various isotope ratios observed in cold fusion and accompanying nuclear transmutations. The ability to predict correctly the isotope ratios suggests that the model is on the right track. A further finding is that the predicted isotope ratios correspond to those appearing in Nature which suggests that LENR is perhaps more important than hot fusion in solar interior as far as nuclear abundances are considered. TGD leads to the same proposal and Lithium anomaly could be understood as one implication of LENR. The basic step of the reaction would rely on weak interactions: the proton of hydrogen atom would transform to neutron by capturing the electron and therefore would overcome the Coulomb barrier. This transformation is extremely slow unless the value of Planck constant is so large that weak bosons have Compton lengths of order atomic length scale.

1 Introduction

Widom and Larsen (for articles see the Widom Larsen LENR Theory Portal [C2] (`http://newenergytimes.com/v2/sr/WL/WLTheory.shtml`)) have proposed a theory of cold fusion (LENR) [C1], which claims to predict correctly the various isotope ratios observed in cold fusion and accompanying nuclear transmutations. The ability to predict correctly the isotope ratios suggests that the model is on the right track. A further finding is that the predicted isotope ratios correspond to those appearing in Nature which suggests that LENR is perhaps more important than hot fusion in solar interior as far as nuclear abundances are considered. TGD leads to the same proposal and Lithium anomaly could be understood as one implication of LENR [K3]. The basic step of the reaction would rely on weak interactions: the proton of hydrogen atom would transform to neutron by capturing the electron and therefore would overcome the Coulomb barrier [K2].

1.1 Challenges of the model

The model has to meet several challenges.

1. The electron capture reaction $p + e \rightarrow n + \nu$ is not possible for ordinary atom since the mass difference of neutron is 1.3 MeV and larger than electron mass .5 MeV (electron has too small kinetic energy). The proposal is that strong electric fields at the catalyst surface imply renormalization effects for the plasmon phase at the surface of the catalyst increasing electron mass so that it has width of few MeVs [C6]. Physically this would mean that strong em radiation helps to overcome the kinematical threshold for the reaction. This assumption [C4]: the claim is that the mass renormalization is much smaller than claimed by Widom and Larsen.

2. Second problem is that weak interactions are indeed very weak. The rate is proportional to $1/m_W^4$, $m_W \sim 100$ GeV whereas for the exchange of photon with energy E it would be proportional to $1/E^4$. For $E \sim 1$ keV the ratio of the rates would be of the order of 10^{-48}!

   This problem could be circumvented if the transition from proton to neutron occurs coherently for large enough surface patch. This would give rate proportional to N^2, where N is the number electrons involved. Another mechanism hoped to help to get high enough reaction rate is based on the assumption that the neutron created by the capture process has ultra-low momentum. This is the case if the mass renormalization of electron is such that the energies of the neutrons produced in the reaction are just above the kinematical threshold. Note however that this reduces the electon capture cross section. The argument is that the absorption rate for neutron by target nucleus is by very general arguments proportional to $1/v_n$, v_n the velocity of neutron. Together these two mechanisms are hoped to give high enough rate for cold fusion.

3. The model must also explain why gamma radiation is not observed and why neutrons are produced much less than expected. Concerning gamma rays one must assume that the heavy electrons of the plasmon phase assigned to the surface of the catalyst absorb the gamma rays and re-emit them as infrared light emitted to environment as heat. Ordinary electrons cannot absorb gamma rays but heavy electrons can [C5], and the claim is that they do transform gamma rays to infrared photons. If the neutrons created in LENR have ultra-low energies their capture cross sections are enormous and the claim is that they do not get out of the system.

4. The assumption that electron mass is renormalized so that the capture reaction can occur but occurs only very near threshold so that the resulting neutrons are ultraslow has been criticized [?]

The TGD inspired solution of the problems relies on the hierarchy of phases labelled by effective value of Planck constant coming as integer multiple of the ordinary Planck constant identified as dark matter. Compton lengths of particles in this kind of phase are scaled up by $\sqrt{h_{eff}/h}$. If the value of n is so large that weak boson Compton lengths are of the order of atomic length scale, weak bosons are effectively massless below atomic length scale and weak interactions become as strong as electromagnetic interactions below this scale. This makes possible for the proton to transform to neutron by the exchange of W boson with target nucleus so that the the problem for kinematics is circumvented. The large value of Planck constant suggests that neutrons and gamma rays do not interact with visible matter. Alternatively, the huge de Broglie wavelength of dark neutron could this mean that neutron absorbtion cross section in reaction volume assumed to contain dark nuclei increases dramatically and neutrons cannot escape the reaction region. Also the emitted dark gamma rays could decay to bunches of visible photons with radio wave lengths.

2 TGD variant of the model

TGD allows to consider two basic approaches to the LENR.

1. **Option I** involves only dark nucleons and dark quarks. In this case, one can imagine that the large Compton length of dark proton - at least of order atomic scale - implies that it overlaps target nucleus, which can see the negatively charged d quark of the proton so that instead of Coulomb wall one has Coulomb well.

2. **Option II** involves involves both dark weak bosons and possibly also dark nucleons and dark electrons. The TGD inspired model for living matter - in particular, the model for cell membrane involving also Z^0 membrane potential in the case of sensory receptor neurons [K1] - favors the model involving both dark weak bosons, nucleons, and even electrons. Chiral selection for biomolecules is extremely difficult to understand in standard model but could be understood in terms of weak length scale of order atomic length scale at least: below this scale dark weak bosons would be effectively massless and weak interactions would be as strong as em interactions. The model for electrolysis based on plasmoids identified as primitive life forms supports also this option. The presence of dark electrons is suggested by Tesla's cold currents and by the model of cell membrane.

   This option is fixed quantitatively by the condition that the Compton length of dark weak bosons is of the order of atomic size scale at least. The ratio of the corresponding p-adic size scales is of order 10^7 and therefore one has $h_{eff} \sim 10^{14}$. The condition that $h_{eff}/h = 2^k$ guarantees that the phase transion reducing h_{eff} to h and increasing p-adic prime p by about 2^k and p-adic length scale by $2^{k/2}$ does not change the size scale of the space-time sheet and liberates cyclotron magnetic energy $E_n(1-2^{-k}) \simeq E_n$.

Consider next **Option II** by requiring that the Coulomb wall is overcome via the transformation of proton to neutron. This would guarantee correct isotope ratios for nuclear transmutations. There are two options to consider depending on whether a) the W boson is exchanged between proton nucleus (this option is not possible in standard model) or b) between electron and proton (the model of Widom and Larsen relying on the critical massivation of electron).

1. **Option II.1**. Proton transforms to neutron by exchanging W boson with the target nucleus.

   (a) In this case kinematics poses no obvious constraints on the process. There are two options depending on whether the neutron of the target nucleus or quark in the neutral color bond receives the W boson.

   (b) If electron and proton are dark with $h_{eff}/h = n = 2^k$ in the range $[10^{12}, 10^{14}]$ the situation can change since W boson has its usual mass from the point of view of electron and proton. $\hbar^4/m_W^4$ factor in differential cross section for 2-to-2 scattering by W exchange is scaled up by n^4 (see the appendix of [A1] so that effectively m_W would be of order 10 keV for ordinary $\hbar$.

   (c) One can argue that in the volume defined by proton Compton length $\lambda_p \simeq 2^{-11}\lambda_e \in [1.2, 12]$ nm one has a superposition of amplitudes for the absorption of dark proton by nucleus. If there are N nuclei in this volume, the rate is proportional to N^2. One can expect at most $N \in [10^3, 10^6]$ target nuclei in this volume. This would give a factor in the range $10^9 - 10^{12}$.

2. **Option II.2**: Electron capture by proton is the Widom-Larsen candidate for the reaction in question. As noticed, this process cannot occur unless one assumes that the mass of electron is renormalized to have a value in a range of few MeV. If dark electrons are heavier than ordinary, the process could be mediated by W boson exchange and if the electron and proton have their normal sizes the process occurs with same rate as em processes.

   If electron and proton are dark with $h_{eff}/h = n \in [10^{12}, 10^{14}]$ the situation can change since W boson has its usual mass from the point of view of electron and proton. 2-to-2 cross section is proportional to $\hbar^4$ and is scaled up by n^4. One the other hand, the naive expectation is that $|\Psi(0)|^2 \propto m_e^3/h_{eff}^3 \propto 1/n^{-3}$ for electron is scaled by n^{-3} so that the rate is increased by a factor of order $n \in [10^{12}, 10^{14}]$ (electron Compton length is of order cell size scale! instead of Angstrom) from its ordinary value. This is not enough.

   On the other hand, one can argue in the volume defined by proton Compton size one has a superposition of amplitudes for the absorption of electron. If there are N dark electrons in this volume, the rate is proportional to N^2. One can expect at most 10^6 dark electrons in the volume of scale 10 nm so that this could give a factor 10^{12}. This would give amplification factor 10^{26} to the weak rate so that it would be only by two orders of magnitude smaller than the rate for massless weak bosons.

There are also other strange features to be understood.

1. The absence of gamma radiation could be due to the fact that the produced gamma rays are dark. For $h_{eff}/h \in [10^{12}, 10^{14}]$ the energy frequency of 1 MeV dark gamma ray would correspond to that of photon with energy of [1,.1] μeV and thus to radiowave photon with wavelength of order 1 m and frequency of orer 3×10^8 Hz. In Widom-Larsen model the photons would be infrared photons. The decay of the dark gamma ray to a bunch of ordinary radiowave photons should be observed as radio noise. Note that Gariaev has observed transformation of laser light scattered from DNA to radio wave photons with frequencies down to 1 kHz at least.

2. The absence of the neutrons could be understood if they are dark and simply do not interact with visible matter before phase transition to ordinary neutrons. One can imagine an alternative interpretation allowing the interaction and assuming that nuclei are dark in the reaction volume. The large Compton wavelength implies that dark neutrons are absorbed by dark nuclei coherently in a volume of order 1.2-12 nm so that an additional amplification factor $N^2 \in [10^9, 10^{12}]$ would be obtained. The absorption cross section for neutrons should be proportional to $\hbar^2$ giving a huge amplification factor in the range $[10^{24}, 10^{48}]$. Effectively this corresponds to the assumption of Widom and Larsen stating that neutrons have ultra-low momentum.

The natural question is why h_{eff} us such that the resulting scale as photon wavelength corresponds to energy in scale 10-100 keV. The explanation could relate to the predicted exotic nuclei obtained by replacing some neutral color bonds connecting nucleons with charged ones and exchange of weak boson would affect this replacement. Could the weak physics associated with $h_{eff} \in [10^{12}, 10^{14}]$ be associated with dark color bonds? The reported annual variations of the nuclear reaction rates correlating with the distance of Earth from Sun suggest that these variations are induced by solar X rays [C3].

REFERENCES

Mathematics

[A1] C. Iztykson and J-B. Zuber. *Quantum Field Theory*, volume 549. Mc Graw-Hill, New York, 1980.

Particle and Nuclear Physics

[C1] Summaries of Widom-Larsen theory. `http://newenergytimes.com/v2/sr/WL/WLTheory.shtml#summary`.

[C2] Widom-Larsen LENR Theory Portal. `http://newenergytimes.com/v2/sr/WL/WLTheory.shtml`.

[C3] J. H. Jenkins et al. Evidence for Correlations Between Nuclear Decay Rates and Earth-Sun Distance. `http://arxiv.org/abs/0808.3283`, 2008.

[C4] P. L. Hagelstein and I. U. Chaudhary. Electron mass shift in nonthermal systems. `http://arxiv.org/abs/0801.3810`, 2008.

[C5] A. Widom and L. Larsen. Absorption of Nuclear Gamma Radiation by Heavy Electrons on Metallic Hydride Surfaces. `http://arxiv.org/abs/cond-mat/0509269`, 2005.

[C6] A. Widom and L. Larsen. Theoretical Standard Model Rates of Proton to Neutron Conversions Near Metallic Hydride Surfaces. `http://arxiv.org/abs/nucl-th/0608059`, 2006.

Books related to TGD

[K1] M. Pitkänen. Dark Forces and Living Matter. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#darkforces`, 2006.

[K2] M. Pitkänen. Dark Nuclear Physics and Condensed Matter. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#exonuclear`, 2006.

[K3] M. Pitkänen. Nuclear String Hypothesis. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#nuclstring`, 2006.