# Illustrations of a Modified Standard Model: Part 2-the pion/muon decays and the neutrino detector nuclear reactions

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**Abstract: The concepts of a proposed Modified Standard Model are applied to explain the charged pion and muon decays along with an analysis of the nuclear reactions involved in major neutrino detection experiments.**

**This paper is the fourth in a series of papers in which a major modification to the Standard Model is being proposed. In this paper the concepts of the proposed model will be applied to the decay schemes of the charged pion and muon and will also provide insight into the nuclear reactions being used to detect neutrinos.**

**The proposed Modified Standard Model came about after a closer examination of particle decays. For example, the decay of a free neutron into a proton, an electron, and a neutrino did not add up to the configuration of udd from the Standard Model. In contrast, the Modified Standard Model identifies the free neutron as $u\bar{u}d\bar{e}$ and the decay takes place as the d-quark decays to an electron (e), a neutrino ($\nu$), and a proton ($\bar{u}u\bar{e}$). In a similar manner, the proposed (but not yet observed) decay of a proton should yield 2 photons and a positron, exactly what the proposed configuration contains ($\bar{u}u\bar{e}$); each u-quark becomes a photon and $\bar{e}$ is a positron.**

**In my first paper, A Proposed Modification of the Standard Model: The u-, d-, and s-quarks, ( http://vixra.org/, High Energy Particle Physics #1301.0197, January 2013), I presented a model for the internal components of u-, d-, and s-quarks as well as photons, electrons, pions, muons, protons, and neutrons. The second paper, Schematic Diagrams Illustrating Baryon Content and Decay Patterns Using New Configurations, (http://vixra.org/, High Energy Particle Physics #1303.0052, March 2013), was directed specifically at the family of baryons. The major result of the second paper is that each baryon considered appears to consist of a muon-like structure with a strong attachment to a positron or electron equivalent. The third paper, Illustrations of a Modified Standard Model: Part 1-The Solar Proton-Proton Cycle, (http://vixra.org/, High Energy Particle Physics #1402.0154, February 2014), applied the concepts of the proposed Modified Standard Model to the helium-producing processes on the sun, explaining each step in more detail and identifying the type and number of protons and neutrons in each isotope. In each case the Modified Standard Model has produced equations in which spin and electric charge were balanced.**

**This paper consists of four sections.**

**<u>Section 1</u>. A condensed description of the basic concepts of the proposed Modified Standard Model along with the specific notations used by the model.**

**This is necessary because some of the notations conflict with those of the Standard Model. For example, in the Modified Standard Model the standard positive proton is designated by $\overline{p}$ . The overline above the $\overline{p}$ indicates positive charge, not an anti-particle. The overline over the letter $\overline{e}$ (the positron or equivalent) also indicates positive charge. However, in the case of the neutrino, the overline over the neutrino symbol ($\overline{\nu}$) indicates that this type of neutrino is involved in developing positive charge, although by itself it does not have electric charge. The overline over a u-quark is really unnecessary because it has no charge and is its own anti-particle.**

**<u>Section 2</u>. Application of the Modified Standard Model to the decay of a negative pion and the decay of a negative muon.**

**It was a closer examination of these two decay schemes that allowed me to identify both the anti-mu neutrino ($\overline{\nu}_\mu$) and anti-electron neutrino ($\overline{\nu}_e$) as a simple neutrino ($\nu$) and both the mu neutrino ($\nu_\mu$) and electron neutrino ($\nu_e$) with a simple anti-neutrino ($\overline{\nu}$). This is a change from my first paper.**

**<u>Section3</u>. A Summarized list of the particle interactions underlying the nuclear reactions used in a majority of neutrino detection experiments**

**<u>Section 4</u>. A comparison between the proposed Modified Standard Model and the Standard Model in terms of explaining each type of nuclear reaction used in detecting neutrinos.**

**For the Modified Standard Model an equivalent equation is provided along with a detailed schematic explanation of process involved. A list of neutrino experiments accompanies each category of nuclear reactions.**

## 1. Proposed Modified Standard Model
## Condensed Concepts and Notations

**1. Neutrinos**

**$\bar{\nu}$ replaces $\nu_e$ and $\nu_\mu$ and is associated with positive charge.**
**$\nu$ replaces $\bar{\nu}_e$ and $\bar{\nu}_\mu$ and is associated with negative charge.**
**($\nu_\mu$ is associated with higher energies than $\nu_e$.)**

**2. Photons**

**A regular photon consists of ($\nu\ \bar{\nu}$).**
**There is also a heavy, high energy photon, (d $\bar{d}$).**

**3. u-quarks**

**A u-quark consists of ($\nu\ \bar{\nu}$) and is its own antiparticle.**
**A u-quark has zero charge and spin of 0 or 1.**
**The arrangement of the neutrino pair may differ from that of a photon.**

**4. d-quarks**

**A d-quark (d) consists of an anti-neutrino connected to 3 neutrinos and has a negative charge.**

$$\begin{array}{ccccc} \nu & - & \bar{\nu} & - & \nu \\ & & | & & \\ & & \nu & & \end{array}$$

**An anti d-quark ( $\bar{d}$ ) consists of a neutrino connected to 3 anti-neutrinos and has a positive charge.**

$$\begin{array}{ccccc} \bar{\nu} & - & \nu & - & \bar{\nu} \\ & & | & & \\ & & \bar{\nu} & & \end{array}$$

**Electric charge is created by a combination of one neutrino and two opposite neutrinos. The type of charge is determined by the two similar neutrinos. The third like neutrino neither adds nor distracts from the electric charge. d-quarks have spins of ½.**

**5. <u>electrons and positrons</u>**

The electron ( e ) has the configuration: $\nu$ - $\bar{\nu}$ - $\nu$

The positron ( $\bar{e}$ ) has the configuration: $\bar{\nu}$ – $\nu$ - $\bar{\nu}$

**6. P<u>ions</u>**

The positive pion is $u\bar{d}$ and the negative pion is $\bar{u}d$. The neutral pion can be either $u\bar{u}$ or $d\bar{d}$.

**7. M<u>uons</u>**

The positive muon is $u\bar{e}$ and the negative muon is $\bar{u}e$.

**8. P<u>rotons</u>**

The common proton is $\bar{u}u\bar{e}$ (in contrast to the Standard Model with uud).

A high energy or "heavy" proton of $\bar{d}d\bar{e}$ is also being proposed.

**9. N<u>eutrons</u>**

There are three types of neutrons:

$d\bar{e}$ super-bound neutron

$\bar{u}d\bar{e}$ bound neutron

$u\bar{u}d\bar{e}$ free neutron

Outside of a nucleus the d quark within the free neutron is unstable and decays to an electron and a neutrino.

$$u\bar{u}d\bar{e} \rightarrow \bar{u}u\bar{e} + e + \nu$$

## 2. The Charged Pion and Muon Decay Patterns

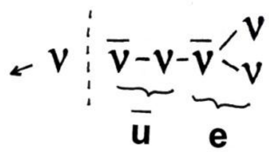
A careful inspection of the decay of the negative pion and the subsequent decay of the negative muon allows the identification of the component neutrinos within these particles.

In the negative pion decay, the resulting anti-muon neutrino ($\bar{\nu}_\mu$) can be replaced with just a simple neutrino ($\nu$).

**The Standard Model versus the Modified Model**

**pion$^-$ decay** $\pi^-$

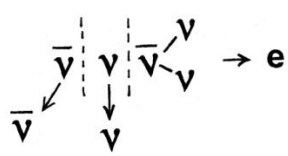
| Standard Model | Modified Model |
|---|---|
| $\bar{u}d \rightarrow \mu + \bar{\nu}_\mu$ | $\bar{u}d \rightarrow \bar{u}e + \nu$ |




Applying this result to the muon, the first neutrino breaking away from the negative muon, a $\nu_u$ neutrino, would correspond to a simple anti-neutrino, $\bar{\nu}$ . The second neutrino ($\bar{\nu}_e$) produced in the decay of the negative muon would then be the simple neutrino, $\nu$, leaving behind an electron.

**muon$^-$ decay** $\mu$

| Standard Model | Modified Model |
|---|---|
| $\mu \rightarrow \nu_\mu + e^- + \bar{\nu}_e$ | $\bar{u}e \rightarrow \bar{\nu} + e + \nu$ |

## 3. Nuclear Reactions Used in Neutrino Detection

**A review of the major neutrino detection experiments shows that they can be grouped into 6 major categories.**

### Electron Neutrinos

**Category 1**

$$\nu_e + n \rightarrow p^+ + e^-$$

**Category 2**

$$\bar{\nu}_e + p^+ \rightarrow e^+ + n$$

**Category 3**

$$p^+ \rightarrow n + e^+ + \nu_e$$

**Category 4**

$$\nu_e + n \rightarrow p^+ + e^- + 2\gamma$$

### Muon Neutrinos

**Category 5**

$$\nu_\mu + n \rightarrow \mu^- + p^+$$

**Category 6**

$$\bar{\nu}_\mu + p^+ \rightarrow \mu^+ + n$$

**Each of these categories can then be analyzed to show the different interpretations of the nuclear reactions between the Standard Model and the proposed Modified Standard Model.**

## 4- Detailed Analysis of Neutrino Detection Nuclear Reactions

## Neutrino Detectors- Category 1

**Standard Model**

$\nu_e + n \rightarrow p^+ + e^-$

**Modified Model**

$\bar{\nu} + n \rightarrow \bar{p} + e$ (this n is a bound neutron- $\bar{u}d\bar{e}$)

**Modified Schematic**

$$\bar{\nu} + \bar{u}d\bar{e} \rightarrow \bar{u}\,\bar{\nu}\,(\nu\, e)\bar{e} \rightarrow \bar{u}(\bar{\nu}\,\nu)\bar{e} + e \rightarrow \underset{\text{proton}}{\bar{u}u\bar{e}} + e$$

$\downarrow$

$e$ ejected

The $\bar{\nu}$ is absorbed into the bound neutron and the d-quark dissociates to an electron and neutrino. The electron is ejected and the $\bar{\nu}$ combines with $\nu$ to form a u-quark.

**Type 1 Neutrino Detectors**

| | |
|---|---|
| GALLEX and GNO | $\nu_e + {}^{71}Ga \rightarrow {}^{71}Ge + e^-$ |
| HALO | $\nu_e + {}^{208}Pb \rightarrow {}^{209}Bi + e^-$ |
| Homestake Chlorine | $\nu_e + {}^{37}Cl \rightarrow {}^{37}Ar + e^-$ |
| Homestake Iodine | $\nu_e + {}^{127}I \rightarrow {}^{127}Xe + e^-$ |
| MiniBooNE | $\nu_e + \text{nucleus} \rightarrow X + e^-$ |
| MOON | $\nu_e + {}^{100}Mo \rightarrow {}^{100}Tc + e^-$ |
| NovA | $\nu_e + n \rightarrow X + e^-$ |
| SAGE | $\nu_e + {}^{71}Ga \rightarrow {}^{71}Ge + e^-$ |
| SNO | $\nu_e + {}^{2}H \rightarrow 2\,p^+ + e^-$ |
| SuperK | $\nu_e + n \rightarrow p^+ + e^-$ |

## Neutrino Detectors- Category 2

### Standard Model

$\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$

### Modified Model

$\nu + \bar{p} \rightarrow \bar{e} + n$ ($\bar{p}$ is a heavy/high energy proton)

(n is a bound neutron- $\bar{u}d\bar{e}$)

### Modified Schematic

$$\nu + \bar{d}d\bar{e} \rightarrow \nu\,(\bar{\nu}\,\bar{e})d\bar{e} \rightarrow (\bar{\nu}\,\nu)d\bar{e} + \bar{e} \rightarrow \underbrace{\bar{u}d\bar{e}}_{\text{bound neutron}} + \bar{e}$$

$\downarrow$

$\bar{e}$ ejected

The $\nu$ is absorbed into a heavy (high energy) proton and the $\bar{d}$-quark dissociates to a positron and anti-neutrino. The positron is ejected and the $\nu$ combines with $\bar{\nu}$ to form an anti-u quark.

## Type 2 Neutrino Detectors

| | |
|---|---|
| Daya Bay | $\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$ |
| Double Chooz | $\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$ |
| KamLAND | $\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$ |
| RENO | $\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$ |
| SuperK | $\bar{\nu}_e + p^+ \rightarrow e^+ + n^0$ |

## Neutrino Detectors- Category 3

### Standard Model

$p^+ \rightarrow n^0 + e^+ + \nu_e$

### Modified Model

$\bar{p} \rightarrow n + \bar{e} + \bar{\nu}$ ($\bar{p}$ is a heavy/high energy proton)

(n is a super-bound neutron- $d\bar{e}$)

### Modified Schematic

$\bar{d}d\bar{e} \rightarrow (\bar{\nu}\ \bar{e})d\bar{e} \rightarrow d\bar{e} + \bar{e} + \bar{\nu}$

$\downarrow\ \ \downarrow$ super-bound neutron

$\bar{\nu}\ \ \bar{e}$ both ejected

The d-quark dissociates into a positron and anti-neutrino which are both ejected, leaving behind a super-bound neutrino.

### Type 3 Neutrino Detectors

HOMESTAKE CHLORINE $^{37}Ar \rightarrow {}^{37}Cl + e^+ + \nu_e$

## Neutrino Detectors- Category 4

### Standard Model

$\nu_e + n^0 \rightarrow p^+ + e + \gamma + \gamma$

### Modified Model

$\bar{\nu} + n \rightarrow \bar{p} + e + \gamma$ **(second photon missing)**

**(n is free neutron)**

### Modified Schematic

$$\begin{array}{l} \bar{\nu} + u\bar{u}d\bar{e} \rightarrow u\bar{u}(\bar{\nu}d)\bar{e} \rightarrow \bar{u}u(\bar{\nu}\nu\ e)\bar{e} \rightarrow \bar{u}u\bar{e} + e + \gamma \\ \qquad\qquad\qquad\qquad\qquad\qquad\quad \downarrow\ \downarrow \\ \qquad\qquad\qquad\qquad\qquad\qquad\quad \gamma\ \ e \quad \text{are both ejected} \end{array}$$

**The $\bar{\nu}$ is absorbed into the free neutron. The d-quark dissociates to a neutrino and electron. The electron is ejected and the $\bar{\nu}$ combines with $\nu$ to form a photon which is also ejected. The second photon might result from an unidentified adjustment within the nucleus after the first transformation.**

## Type 4 Neutrino Detectors

**LENS** $\nu_e + {}^{115}In \rightarrow {}^{115}Sn + e^- + \gamma + \gamma$

## Neutrino Detectors- Category 5

### Standard Model

$\nu_\mu + n^0 \rightarrow p^+ + \mu^-$

### Modified Model

$\bar{\nu} + n \rightarrow \bar{p} + \mu$ (n is free neutron)

### Modified Schematic

$$\underbrace{\bar{\nu} + u\bar{u}d\bar{e}}_{\text{free neutron}} \rightarrow u\bar{u}(\bar{\nu}\, d)\bar{e} \rightarrow u\bar{u}(\bar{\nu}\, \nu\, e)\bar{e} \rightarrow \bar{u}u(\bar{u}e)\bar{e} \rightarrow \underbrace{\bar{u}u\bar{e}}_{\text{proton}} + \underbrace{\bar{u}e}_{\text{muon}}$$

$$(\bar{u}e) \downarrow \mu$$

The $\bar{\nu}$ is absorbed into the free neutron and the d-quark dissociates to an electron and neutrino. The $\bar{\nu}$ combines with $\nu$ to form a u quark, which then combines with the e to from a negative muon.

## Type 5 Neutrino Detectors

IND/ICAL $\nu_\mu + Fe \rightarrow \mu- + X$

## Neutrino Detectors- Category 6

### Standard Model

$\bar{\nu}_\mu$ + $p^+$ → $\mu^+$ + n

### Modified Model

ν + p → $\bar{\mu}$ + n (p is heavy proton)

### Modified Schematic

$\nu + \bar{d}d\bar{e} \rightarrow (\nu\,\bar{d})d\bar{e} \rightarrow (\nu\,\bar{\nu}\,\bar{e})d\bar{e} \rightarrow (u\bar{e}) + d\bar{e}$

($\bar{d}d\bar{e}$ is heavy proton, $u\bar{e}$ is $\mu^+$, $d\bar{e}$ is super-bound neutron)

The neutrino is absorbed into the heavy proton and the $\bar{d}$-quark dissociates to an anti-neutrino and positron equivalent. The ν combines with $\bar{\nu}$ to form a u quark, which then combines with the $\bar{e}$ to form the positive muon.

This nuclear reaction is almost the same as the reaction in category 2 except that the created u quark joins with the $e^+$ to form a $u^+$, leaving behind a super-bound neutron ($d\bar{e}$) instead of a bound neutron ($\bar{u}d\bar{e}$).

### Type 6 Neutrino Detectors

NEVOD $\bar{\nu}_\mu$ + $p^+$ → $\mu^+$ + n

## Conclusion

**Whenever the concepts of the proposed Modified Model are applied to a nuclear reaction or particle decay they seem to work and produce relatively simple answers. I realize that accepting these ideas will be very difficult because of all the decades spent in research and experimentation trying to back the Standard Model. It would be almost like having to start over again. But this has happened in science many times before.**

**This is still a work in progress with many questions still to be answered. Future papers still in development will be directed towards particle masses, binding energies, and the substructure configurations of sub-atomic particles. Hopefully, some clarification of the phenomena of energy, mass, and electric charge will also result.**