Nuclear Magneton Theory of Mass Quantization
"Unified Field Theory"

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Abstract

A new theory is hereby proposed which is founded on the concept of quantized elementary discrete mass particles, called herein the Magneton and Antimagneton. The particles are conceived to be spinning magnetic dipoles with sufficient mass to produce the dipole-dipole interaction sufficient to act at ultra-short range – the source of the Nuclear Force Field (NFF) - which now has a gravitational component. Since the NFF contains this component it can be thought of as the long searched for Unified Field. The theory is termed the Nuclear Magneton Theory of Mass Quantization, or NMT.

Keywords: Nuclear Magneton Theory, Mass-Quantization-Energy-Quantization, E=mc², E=mbc, E=mb², Mass-Energy-Equivalence, universal particle speed constant b, Mass-Energy-Conformity-Principle, Magneton particle.

1. Introduction

In classical physics mass plays a triple role. First, it is a measure for how easy it is to influence the motion of a body. Secondly, mass is a measure of how many atoms there are in a body. Thirdly, in Newton’s theory of gravity, mass determines how strongly a body attracts other bodies via the gravitational force. In special relativity one can also define a mass that is a measure for body’s resistance to change its motion; however the value of this relativistic mass depends on the relative motion of the body and the observer. The relativistic mass is the "m" in Einstein's famous E=mc² (cf. equivalence of mass and energy).

For Einstein, mass was (more precisely), relativistic mass (the property that determines how difficult it is to change a body's speed or its direction of motion). Mass and energy are simply two different names for one and the same physical quantity. Whenever a system has an energy E, it automatically has the relativistic mass m=E/c²; whenever a system has the mass m, you need to assign it an energy E=mc². Once the mass is known, so also is the energy, and vice versa. In that context, it makes no sense to talk about the "transformation of mass into energy" - where there's one, there's the other. The same result comes from the four-momentum E²-p²=m² where c=1, which describes the moving mass; as we can see that if the momentum is zero the MASS of the system equals the ENERGY of the system. Nevertheless, the relativistic mass m=E/c² and the four-momentum are based on the proposed isotropic property of the light while some researchers[1,2] found that the cosmic microwave background radiation is anisotropic.

1 The four-momentum formula is based on Lorentz invariant. Einstein postulated in his 1905 article that light speed is isotropic in all inertial frames in order to derive the Lorentz Transformations. Smoot found out that the light speed is anisotropic on earth. Therefore, four-momentum formula becomes invalid. Smoot et al. have observed, that radiation
Whenever two or more objects are bound together by strong forces, there is a binding energy - the energy needed to pry these objects apart. Since Einstein, we believe that energy and mass are equivalent. To this binding energy there corresponds a mass. It is called the mass defect because, by this amount, the mass of the component object is less than the sum of the masses of its parts.

The conversion of mass into energy is still a matter of dispute among the scientists although Einstein confirmed this concept in 1932 after the Cockcroft and Walton experiments. As in classical pre-Einstein physics, the concept of "energy" comprised a host of sub-definitions for different sorts of energy, sub-definitions like those for the kinetic energy associated with any moving body, the energy of electromagnetic radiation, thermal energy, and the binding energy that needs to be taken into account whenever there is a force holding together two objects to form a composite object. Yet all these different definitions can be viewed as facets of a single physical quantity, energy, in which the possibility of transformations between the different energy forms, exist. For instance, you can increase a body's temperature (and thus its thermal energy) by letting it absorb electromagnetic radiation energy. In these transformations, the total sum of all the different kinds of energy - the total energy is constant and implies conservation of energy.

Classically, energy can be transformed from one type into another, but it can neither vanish nor be created from nothing. This conservation of energy holds not only in classical physics but in the extremes of relativity and in the quantum condition. When motion is near the velocity of light or distances are extremely small, we require a completely new type of energy: an associated energy solely because of its mass – whether the object is part of a bound system or moving independently. It is a form of energy simply because of its mass and is termed the particle's rest energy, and it is related to the particle's rest mass, rest energy = (rest mass) times c². At the nuclear level things become even more demanding. Nuclei are composite entities consisting of composite particles, protons and neutrons. Firstly, there are the nuclear forces binding protons and neutrons together. Then, secondly, there are further forces, for instance the electric force with which all the protons repel each other due to the fact they all carry the same electric charge. In addition there is a binding energy - the energy required to pry apart an assemblage of protons and neutrons or to overcome the electric repulsion between two protons.

**a. Nuclear Structure**

Considering the macro molecular, molecular, atomic, nuclear, sub-nuclear, quantum and relativistic domains we are herein concerned only with the smallest and most docile sub-nuclear domain. In this context and for the sub-nuclear domain in particular, the concepts of rest mass and mass – energy equivalence must be questioned.

The most accepted Standard Model-Extended Theory (SMET) is the quark-model, which was independently proposed by physicists Murray Gell-Mann and George Zweig in 1964. However the quark theory has short comings in that it cannot explain the nuclear transformation of the proton and neutron in a clear way. The quark theory tells us that the neutron is created from three quarks (two down and one up). The quark theory proposes that a decrease in neutron and proton mass is explained coming from the direction of constellation LEO is blue shifted whereas radiation coming from the opposite direction is red shifted. Putting the measured shifts into the Doppler shift equation yielded the absolute motion of our solar system to be equal to about 370km/s in the direction of constellation LEO. Hence, light propagation is anisotropic on earth. The finding of Smoot refuted the special relativity which, based on Lorentz, and Smoot received the Nobel Prize 2006.

Einstein: “It followed from the special theory of relativity that mass and energy are both but different manifestations of the same thing—a somewhat unfamiliar conception for the average mind. Furthermore, the equation E = mc², in which energy is put equal to mass, multiplied with the square of the velocity of light, showed that very small amounts of mass may be converted into a very large amount of energy and vice versa. The mass and energy were in fact equivalent, according to the formula mentioned before. This was demonstrated by Cockcroft and Walton in 1932, experimentally”. In 1932, the English physicist John Cockcroft and the Irish physicist Ernest Walton produced a nuclear disintegration by bombarding Lithium with artificially accelerated protons. The following reaction took place: \(^{7}_3\text{Li} + \(^1_1\text{H}\rightarrow^{4}_2\text{He} + \text{Energy.} \)
in terms of the binding energy for the host nucleus. If someone were to ask “which part of the three quarks of the neutron and the proton converts into binding energy when the neutron and the proton form the deuterium nucleus?” the answer is unclear.

Another problem occurs, when we assume that the proton (938.272 MeV/c\(^2\)) is composed of two up quarks (each quark is 2.4 MeV/c\(^2\)) and one down quark (4.8 MeV/c\(^2\)). They consists of 1.0232 % (9.6 MeV/c\(^2\) of 938.272 MeV/c\(^2\)), the remainder of the proton mass being due to the kinetic energy of the quarks and to the energy of the gluon fields that bind them together. If we acquiesce that these quarks has kinetic energy of 928.672 MeV/c\(^2\), then a reasonable question would arise: what is the source of this everlasting energy? Suppose we consent that the energy has mass and the total mass of proton is 9.6 MeV/c\(^2\) due to quarks and 928.672 MeV/c\(^2\) due to kinetic energy (total is 938.272 MeV/c\(^2\)), and we then apply this concept to the binding energy calculation. Does this mean that the binding energy also has mass (as SMT theory says)? Is that correct? If it is correct, it implies that the real or actual mass of each nuclide will come from \(Z \text{M}_H + N \text{M}_n\) but this has not been found experimentally.

The modern particle physics adopted most theories that are formulated as relativistic quantum field theories (QFT) such as quantum electrodynamics (QED), quantum chromodynamics (QCD), and the Standard Model, SMT. The Standard Model (SM) was born in 1970\[8-11\], as a result of a vast amount of research by thousands of physicists. The standard model groups the electroweak interaction theory and quantum chromodynamics into a structure denoted by the gauge group \(SU(3)\times SU(2)\times SU(1)\). This theory adopted twelve basic building blocks, namely six quarks and six leptons which are ruled by four forces through energy carriers (\(g, g, Z, W\)), the so called bosons. The scientists considered it as a provisional theory because it cannot give a satisfactory answer to experimental results and it does not explain the complete picture.

Several theories have been suggested when attempting to develop a theory of “pre-quarks” in an effort to rationalize theoretically the many parts of the Standard Model that are known only through experimental data.

The Grand Unification Theory (GUT) supposed that at tremendously high energies, the three forces (i.e. electromagnetic, weak, and strong interactions) are merged into one single interaction characterized by one larger gauge symmetry and thus one unified coupling constant\[12-17\]. The new particles predicted by models of grand unification cannot be observed directly by particle colliders because their masses are expected to be of the order of the so-called GUT scale and, thus, far beyond the reach of currently foreseen collision experiments. The present concepts say if gravity is merged with the other three interactions, it would provide a theory of everything (TOE) rather than a GUT. Nevertheless, GUTs are often seen as an intermediate step towards a TOE.

Super-symmetry: this theory proposes that there is a relationship between matter particles, such as fermions (half spin) and force carriers, such as boson (one spin), to create S-particles which include the s-leptons, s-quarks, neutralinos and charginos. For example, for every type of quark, there may be a type of particle called an “s-quark”. Physicists search for such a model as it offers an extension to the more familiar symmetries of quantum field theory, QFT. These particles are so heavy that they need more advanced technology to be verified\[18\]. As of 2011 there is no direct evidence that Super-Symmetry is symmetry of nature\[19-23\].

Superstring theory is a recent model born in 1970, but rooted to Kaluza-Klien theory in 1921, to resolve the issue between the quantum theory and relativity theory regarding the gravity. Particle theory only works when we allege gravity doesn’t exist while the relativity theory only works when we pretend that the universe is purely classical and that quantum mechanics is not needed in our description of nature\[24-26\]. String theory postulates that the fermions within an atom are one-dimensional oscillating lines or “strings” rather than zero-dimensional objects. This theory contains two objects: strings and branes. Of the five string theories, the M-theory suggests that all “particles” that make up matter and energy are comprised of strings measuring at the Planck length; 1.616199x10\(^{-35}\) m. Using the uncertainty principle, these strings exist in an eleven-dimensional universe to prevent tears in the “fabric” of space whereas our own existence is merely a 4-brane inside which exist the 3
space and the one time dimension that we observe\textsuperscript{[27-29]}. These strings vibrate at different frequencies which determine mass, electric charge, color charge (of quarks and gluons), and spin. This theory still does not have an adequate definition in all circumstances. It predicts extremely massive Higgs boson and massless spin-2 particle behaving like the graviton. The major goal of this theory is to treat the universe through both the quantum mechanics and the classical mechanics.

Other theories proposed fundamental particles to support the standard model such as prequarks\textsuperscript{[30]}, maons\textsuperscript{[31]}, haplons\textsuperscript{[32]}, Y-particles\textsuperscript{[33]}, and primons\textsuperscript{[34]} (and others: quinks, tweedles, alphans, rishons, helons)\textsuperscript{[35]}. Among these theories, preon theory, suggested by Pati and Salam in 1974, is the foremost name in the physics community\textsuperscript{[36]}. In 1977, more efforts were made by Terazawa, Chikashige and Akama\textsuperscript{[37]} and in 1979 by Ne’eman\textsuperscript{[38]}, Harari\textsuperscript{[39]} and Shupe\textsuperscript{[40]} independently. A similar paper in 1981 was also reported by Fritzsch and Mandelbaum\textsuperscript{[41]}. In 2008 Mário Everaldo De Souza suggested that each quark is composed of two primons and, thus, all quarks are described by four primons\textsuperscript{[42]}. All these models focused on one main point, that the quark is composed of two or more sub-quark particles. These theories mimic the quark model but in a modified manner. None of these theories have gained wide acceptance in the physics world.

In previous reprints published in 2008\textsuperscript{[43,44]}, we submitted innovative concepts in nuclear physics that pave the way to write this new nuclear theory, NMT, such as conservons and magnetons particles. These particles are the elements of this NMT theory. A pioneering meaning for the \( E=\frac{1}{2}mv^2 \) and \( E=mc^2 \) has been discussed. Moreover, we derived a simple semi-empirical formula, starting from black body radiation, for the \textbf{non-relativistic mass-energy equivalence} \( E=mbc \), which gives 194.177 MeV/bc for each one atomic mass unit, \( u \), and its derivatives for fermions such as \( E=mb^2 \), \( b=\lambda u \), \( p=mb \), \( \lambda=\hbar/mc \) or \( E=\hbar\beta/\lambda \) where the derived \( b \) is a universal particle speed constant which equals to 0.624942362\times 10^8 m/s. This particle speed constant is equal to \textbf{0.2085} of speed of light which represents the optimum speed to be reached by the fermion or the charged and uncharged particles. The magnetic constant for a charged particle was also calculated based on the speed constant \( b \) to be equal to \( \mu_o=2.892 \times 10^{-5} \text{ N/A}^2 \) that means it is greater than magnetic constant \( \mu_o \) of electromagnetic ray by 23 times \( \left( \mu_o=23\mu_o \right)^3 \).

\textbf{b. Problems with Current Nuclear Theory}

The variation in masses of the proton and the neutron in different nuclei are attributed to \textbf{binding energy} – which is different in different nuclear configurations- and this energy has a mass. The annihilation of matter with antimatter due to the mass-energy equivalence, where there is still some controversy, which still has different explanations and the process does not satisfy all the laws of conservation. So if this is the case, why does the electron-positron annihilate while the proton-annihilation of matter with antimatter due to the mass-energy equivalence, where there is still some redundant and \( v^2 \) is \textbf{conversion factor but not} \( v^2 \). This means that the essential issue in this term \( E=\frac{p}{(\frac{1}{2})v_1} \) is the momentum \( p \) while the other two factors (i.e. \( \frac{1}{2} \) & \( v_1 \)) are trivial or insignificant as they do not have any physical meaning. The factor \( \frac{1}{2} \) is redundant and \( v_1 \) is \textbf{unit conversion factor} to express the momentum value in joule units. This is a general rule for the calculation of kinetic energy from any moving mass in macro system. In quantum mechanics, regarding the \( E=mc^2 \) (or \( E=mc^2 \), \( c_o \), or \( E=pc \)), the correct visualization and understanding to this equation supposed be realized in the same way that explained for the kinetic energy above where \( c_o \) is \textbf{unit conversion factor but not} \( c^2 \) as Einstein perceived. This means that the energy equation supposed be interpreted as \( p \) times \( c \) and not \( m \) times \( c^2 \). The principle of conversion of a mass to energy or vice versa is untenable. This pioneering meaning leads to creation of mass-energy conformity principle which will be stated later.

\textsuperscript{1} NMT considers the kinetic energy term \( E=\frac{1}{2}mv^2 \) of macro systems as a simple mathematical function to describe the momentum of the mass in unit of energy and it may be written as a modest multiplication of momentum \( p \) times the velocity \( v_1 \): \( E=\frac{1}{2}pv_1 \) (supposed be understood so), \( E=\frac{1}{2}mv_1v_1 \) (supposed be read so), \( E=\frac{1}{2}mv^2 \) (supposed be written so); the \textbf{first} velocity \( v_1 \) represents the velocity of the moving mass which gives the momentum \( p=mv_1 \) and the \textbf{second} velocity \( v_1 \) here should be considered as \textbf{unit conversion factor} from momentum units to energy units therefore we can say \( v_1 \) is \textbf{conversion factor but not} \( v^2 \). This means that the essential issue in this term \( E=\frac{p}{(\frac{1}{2})v_1} \) is the momentum \( p \) while the other two factors (i.e. \( \frac{1}{2} \) & \( v_1 \)) are trivial or insignificant as they do not have any physical meaning. The factor \( \frac{1}{2} \) is redundant and \( v_1 \) is \textbf{unit conversion factor} to express the momentum value in joule units. This is a general rule for the calculation of kinetic energy from any moving mass in macro system. In quantum mechanics, regarding the \( E=mc^2 \) (or \( E=mc^2 \), \( c_o \), or \( E=pc \)), the correct visualization and understanding to this equation supposed be realized in the same way that explained for the kinetic energy above where \( c_o \) is \textbf{unit conversion factor but not} \( c^2 \) as Einstein perceived. This means that the energy equation supposed be interpreted as \( p \) times \( c \) and not \( m \) times \( c^2 \). The principle of conversion of a mass to energy or vice versa is untenable. This pioneering meaning leads to creation of mass-energy conformity principle which will be stated later.
i.e. photons, W and Z, are still unclear$^4$ and their mechanism as intermediate vector bosons is still indistinct. Although they are considered as “virtual” processes as elements of perturbation theory calculations and don’t occur directly as physical processes, they are far from scientific understanding. Moreover, if the photons and the bosons are part of the same electroweak forces, as Salam-Weinberg-Glashow claimed, then why is the photon massless while W and Z have masses more than 85 times that of a proton. Furthermore, some scientists have searched for Higgs boson to grant the mass to the photons and some others had found the upper limits for the photon rest mass in the range of $10^{-46} - 10^{-52}$ Kg$^{[48]}$. Whether they arrive to an actual value for photon rest mass ($m_\gamma$) or not, the photoelectric effect and Compton Effect have to be reviewed as such tiny mass or massless particles cannot impact the electron.

c. The Aim of Nuclear Magneton Theory

The New Magneton Theory, proposed in this paper, attempts to provide solutions to these riddles. The aim of this theory is to set up innovative bases, concepts, and principles in nuclear science using QT to modify some foundations of QFT to avoid using the concept of mass-energy conversion, quarks and bosons. In this paper we will write the main outlines of this novel nuclear theory. It is the “Nuclear Magneton Theory of Mass Quantization”, NMT. This theory will explain how matter in the universe is built from the two particles only, which are magneton and its antimagneton particle. These magnetons outside of the fermions are well-known as electron, muon and tau-neutrinos ($\nu_e$, $\nu_\mu$, and $\nu_\tau$) – alluded to by the physics community. SMT considers these neutrinos as three different particles while NMT thought that the electron-neutrino is a single magneton and the muon and tau neutrinos are special packages of magnetons released from the fermions during the nuclear processes. NMT believes that the behavior of magnetons inside the fermion is different from their behavior outside of the fermion. Inside the fermion, these magnetons exist as compact closed circular packages of quantized mass and are bound through very high nuclear forces of ultra-short range while outside of the fermion they exist as very tiny and weak discrete particles retaining small mass and magnetic properties which are known by the so-called electron-neutrino ($\nu_e$). NMT will estimate some properties to these magnetons as we see in the following items.

First: Nuclear Magneton Theory (NMT)

1. NMT Concepts

The NMT believes that the numbers of the basic building blocks are only two, the magneton and its antimagneton rather than twelve (6-quarks, 6-Leptons). These basic building blocks arranged in circular closed quantized packages rings as nmtionic$^5$ shells to form the fermions. Both the electron and the proton have three nmtionic shells, while the neutron has four nmtionic shells. Therefore, the e, p, and n are not considered as point charge (i.e. zero-dimensional objects). Consequently they have center of mass and axis to revolve around. A fundamental premise of The Magneton Theory is that energy cannot create mass but vice versa. Mass can create (not convert to) energy. The massive magnetons create energy through the spinning-rotation motion based on the new mass-energy conformity principle. The spinning-rotating magnetons are considered to interact as magnetic dipoles, with electric, magnetic and gravitational properties to achieve the four forces, replacing fields being tangible force carrier’s bosons. Furthermore, this NMT believes that the proton and the neutron are bound by four-force particles conservons. NMT uses a novel neutron mass defect and standard energy

$^4$ Although QFT viewed the photons as field quanta, but NMT would like to ask what is the source of the photon? Is it a part of the electromagnetic waves or is it an independent particle? If the photon is a part of the electromagnetic wave, then how does it become a particle? And if it is an independent particle, then from where does it come and how does it become an energy carrier?

$^5$ Definition of nmtionic shells: They are the shells that form the fermion as explained in item-2.3. The word nmtionic is the adjective raised from NMT (nmt+ion-ic).
of formation \( E_i^o \) rather than mass defect in all nuclear calculations based on Mass Quantization Principle.

The NMT theory does not use mass-energy conversion to describe the nuclear reactions and processes and binding energies in the nuclei but uses its own mass-energy conformity principle in addition to neutron mass defect and \( \Delta E^o \). The Q values of NMT \( E_i^o \) are more comprehensive than that of SMT because it covers both closed and open nuclear systems.

NMT has totally different interpretations than the primitive \( \beta \)-ray theory of Fermi of 1934 where he proposed that the electrons and neutrinos can be created or annihilated. NMT confirms that there is no annihilation into photons in the matter but rather disintegration of magnetons packages into single magneton (or \( \nu_e \)) because matter is quantized. The NMT concepts are considered as a parallel to the concepts of the theory of Standard-Model (SMT). NMT concepts represent new philosophical visions in nuclear science.

2. Physical Basis for the Phenomenological Model of NMT

Perhaps the fine structure, as obtained from atomic spectra studies, is the obvious characteristic which produced the hypothesis that the electron has a magnetic moment and an angular momentum, in short a “spin”, as originally suggested by Goudsmit and Uhlenbeck. The vector of the magnetic moment is calculated from the angular momentum vector:

- In atomic physics the Bohr magneton (symbol \( \mu_B \)) is a physical constant and the natural unit for expressing an electron magnetic dipole moment.
- The Bohr magneton is defined in SI Units by
  \[
  \mu_B = \frac{e \hbar}{2m_e}, \quad (9.27400968 \times 10^{-24} \text{J/T})
  \]
  and in Gaussian CGS Units by
  \[
  \mu_B = \frac{e \hbar}{2m_e c}, \quad (9.27400968(20) \times 10^{-21} \text{Erg/G})
  \]

  Where \( e \) is the elementary quantized charge, \( \hbar \) is the reduced Planck constant, \( m_e \) is the electron rest mass, and \( c \) is the speed of light. In NMT, the magneton particle is similar to the electron and both have a magnetic moment measured by Bohr unit. The electron has \(-1.00 \mu_B\) and the magneton has \(10^{-19} \mu_B\) \([46]\).

2.1. Mass Quantization of the Magnetons

NMT is now used to confirm Mass Quantization in a similar way as Energy Quantization. The quantized mass (the magnetons) creates the quantized energy and not vice versa. The mass in the universe is quantized and is composed of a package of elementary discrete mass particles called magnetons.

The quantized mass magneton has the following physical properties:

**I- Magneton Mass:** The mass of this magneton is proposed to be 0.25 eV/c\(^2\) or \( m_m = 4.456654 \times 10^{-37} \) kg. Scientist’s experiments have agreed that the mass of magneton (i.e. electron-neutrino, \( \nu_e \)) is expected to be between 0.2 eV and 2.2 eV\([47,48]\) which are a factor of 11. The KATRIN (Karlsruhe Tritium Neutrino Experiment) experiments will test these mass values in 2015. NMT chose 0.25 eV to be above the critical value 0.2 eV. Any change that will happen to the mass of the magneton in future will not affect the concepts of the NMT theory. We use this figure (0.25 eV) in our nuclear calculation and in calculation of the density of the magneton.

**II- Magneton Length:** The length of the magneton can be given by modifying the Plank-length formula eq-1 as follow: We used particle speed \( b \) instead of wave speed \( c \) and denoted the length by \( l_B \) rather than \( l_P \). The \( l_P \) describes the string length of the wave nature which is \( 1.616199 \times 10^{-35} \) m while \( l_B \) describes the magneton length of particle nature.

\[
l_B = \sqrt{\frac{\hbar G}{b^3}} = 1.698110726 \times 10^{-34} \text{ m}
\]
Where $h$ is reduced plank constant ($1.0545717 \times 10^{-34}$ J.s), $G$ is gravitational constant ($6.67384 \times 10^{-11}$ Nm$^2$kg$^{-2}$ or m$^3$kg$^{-1}$s$^{-2}$), and $b$ is the universal particle speed constant ($b=0.625 \times 10^8$ m/s)$^6$, $l_B$ represents the length of the magneton. In this formula, the particle speed $b$ is used rather than $c$ as these magnetons have a mass and cannot move with speed of light.

From this calculation, it seems that the magneton length (particle nature) is longer by 10.5 times than the string length (wave nature). In the theory, magneton length $l_B$ is of a physical significance because it represents a smaller magnitude of length than any currently instrument could possibly measure. Where the space-time structure ruled by quantum effect, it would become impossible to determine the difference between two locations less than one $l_B$ length apart. This formula eq-2 came from dimension analysis of $b$, $G$ and $h$.

\[
l_B = \text{dim}(b)^{Z_o} \ast \text{dim}(G)^{Z_G} \ast \text{dim}(h)^{Z_h} \quad \text{(Where } Z_o=-1.5, \ Z_G=0.5 \text{ and } Z_h=0.5) \sqrt{\frac{\hbar G}{b^3}} = \text{m} \quad (2)
\]

The quantum field theory QFT also uses speed of light $c$ and newton gravity constant $G$ to calculate Plank length $l_P$, Compton wavelength $l_C$, and Schwarzschild radius $l_S$.

**III- Magneton Magnetic Constant:** The magnetic constant $\mu_b \ (B/H)$ which is the property of a material that is equal to the magnetic flux density $B$ established within the material by a magnetizing field divided by the magnetic field strength $H$ of the magnetizing field. The classical behavior of the electromagnetic field is described by Maxwell’s equations which predict that the speed $c$, with which electromagnetic waves (such as light) propagate through the vacuum, is related to the electric constant $\varepsilon_0$ and the magnetic constant $\mu_0$ by the equation-3;

\[
c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \quad \text{where } \mu_0=1.256637061 \times 10^{-6} \text{ N/A}^2, \ \varepsilon_0=8.854187817 \times 10^{-12} \text{ F/m}^{[50]}
\]

This is one of Maxwell’s equations and it is valid for the speed of light in a vacuum. By introducing the universal particle speed constant $b$, we can write the following alternative version of Maxwell’s equation eq-4 for evaluating the magneton magnetic constant $\mu_b$ which moves with $b$ speed.

\[
b = \frac{1}{\sqrt{\mu_b \varepsilon_0}} \text{ or } \mu_b = \frac{1}{(0.624942 \times 10^8)^2 \times (8.8541878171 \times 10^{-12})} \quad \text{.....(4)}
\]

The calculated value of $\mu_b$ from the above equation is equal to $2.892 \times 10^{-5} \text{ N/A}^2$ which is larger than that of electromagnetic magnetic constant $\mu_e=1.257 \times 10^{-6} \text{ N/A}^2$ by **23 times** and this gives a special magnetic property to the field of the charged particles. This new high value for $\mu_b$ ($\text{H-m}^{-1}=J/(\text{A}^2-\text{m})=\text{N A}^{-2}$) will increase the magnetic field (or flux density) $B$ inside the particle which composed of magnetons (measured in weber; volt-seconds) per square-meter ($\text{V-s/m}^2$) or tesla (T) due to magnetic field strength $H$ ($\text{A m}^{-1}$) as given by the following equation-5;

\[
B = \mu_b H.
\]

It could be suggested that for the charged particle, the magnetic constant $\mu_{b_{cp}}$ for its electromagnetic field will be increased by the charge value i.e. $\mu_{b_{cp}}=Z\mu_b$. For example, the $\mu_b$ value for beta-particle ($Z=1$) is $2.892 \times 10^{-5} \text{ N/A}^2$ while for alpha-particle ($Z=2$) is supposed to be $2 \times (2.892 \times 10^{-5} \text{ N/A}^2)$ or it is larger than that of light by 46 times and so on. This difference in magnetic constant

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6 The universal particle speed constant $b=6.25x10^8$ m/s, $E=mcb$, had been derived from black body radiation using Plank constants. This universal particle speed constant $b$ represents the speed of the electron during its excitation when it jumps from atomic orbital of low level to atomic orbital of upper level. Therefore, this speed represents the maximum speed that can be reached by non-accelerated electron. As we know from particle physics that only two particles are smaller than the electron which are electron neutrino (0.2 eV-2.2 eV) and muon neutrino (170 keV). All other particle physics are heavier than the electron and consequently they will move slower than the electron. The universal particle speed $b$ constant is very suitable for description of the velocities of neutrinos, electrons, protons and neutrons. Therefore, the universal particle speed $b$ constant is very reasonable for these non-accelerating particles when they are emitted from the nuclear reaction or process. The fission product velocities will not exceed $4.5x10^7$ m/s. A speed of emitted neutron or proton from the decay process with 10MeV approximately reaches the speed constant $b$ ($\approx 6.9x10^7$ m/s).
values explains clearly the degree of variance of deflection of gamma, beta and alpha when these rays pass a magnetic field. The bigger value of $\mu_{b,cp}$ the more interaction with field exerted by the device. Lorentz force $F$ will be greater for charged particle as the $B=(\mu_{b,cp}H)$ is higher due to $\mu_{b,cp}$ value (i.e. $F=q[E+vxB]$ or $F=q[E+vx\mu_{b,cp}H]$) that causes change in its motion.

**IV- Magneton Density and Volume:** The shape of the magneton is supposed to be equal to cylindrical shape or nearly so. NMT chose the cylindrical shape because NMT envisaged that the magneton is similar to small magnetic bar which is very close to the cylindrical shape that gives a homogenous magnetic flux to achieve the magnetic force produced by a bar magnet. NMT selected the value $h=3r$ (or $r=h/3$) (Diag-1C) for cylindrical shape (similar to Diag-1D) to get the smallest possible cylindrical shape instead of the critical value $h=1r$ or $h=2r$ which possibly will give deformed cylindrical shape (Diag-1A&B). If we use $h=2r$, it will make a negligible change to the size as seen in the Diag-1.7

The geometry of this spinning-rotating magneton has $C_{xv}$ Schönflies point group symmetry and its volume can be given by $V=\pi r^2 h$ or $V=\pi (h/3)^2 h$ (or $V=\pi h^3/9$) where $h=1.698111 \times 10^{-34} m$. The estimated volume of the magneton is $1.731832 \times 10^{-103} m^3$. The density $d=m/v$ of the magneton will be given by $4.456654 \times 10^{-37} kg/1.731832 \times 10^{-103} m^3$. The density value of magneton is equal to $2.573376 \times 10^{-106} kg/m^3$. This magneton density is very gigantic if it is compared with proton density ($10^{18} kg/m^3$) or electron density ($10^{21} kg/m^3$). NMT thought that this extraordinary density is responsible for generating gravitational force inside the nucleon and for black hole’s massive body as well. **The denser the magnetons package the greater the charged magnetic force.**

**V- Magneton Spin and Moment:** The magneton and its antiparticle have a half-integer spin ($\pm \frac{1}{2}$) and are therefore fermions. The magneton ($\pm \frac{1}{2}$) and its antimagnet ($-\frac{1}{2}$) may be denoted by $m^1$ and $m^\dagger$ respectively. The magnetic force of the magneton $m$, at a given point in space, depends on two factors: the strength $p$ of its poles, and on the vector $l_B$ separating them which equal to $l_B$. The magneton magnetic moment may be given by $m=p/l_B$.

**Diagram-1:** The proper shape of the cylinder with varying the height $h$ with respect to the $r$ and magnetic field of an ideal cylindrical magnet with its axis of symmetry inside the plane

**VI- Quantized Circular Package Description:** These two magnetons are further proposed to exist in compact states within star cores, since the so-called big bang, and they are the sole basic building block units in the particle zoo in the universe. In the stars, these two magnetons are thought to be compacted in matrix to build a circular package of magnetons of quantized mass with partial charge inside the nucleus. These circular closed quantized packages rings are accumulated to reach the quantized mass particle8 in the so-called elementary and the composite particles with spin =½ and final charge positive or negative or neutral (p, e and n). The nucleus has only two permanent nucleons of

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7 The cylinder volume for $h=2r$ will equal to $3.897 \times 10^{-103} m^3$ in comparison with $1.732 \times 10^{-103} m^3$ for $h=3r$. Therefore, the difference between $h=3r$ and $h=2r$ is negligible.

8 The packages are of quantized mass while the particle texture either collect quantized mass (stable) or collect partial quantized mass (unstable) depend on its charge type. **Thus there is a difference between the quantized packages and the particle texture.**
quantized mass particles, i.e. the proton and neutron. All other unstable particles noticed at accelerators and colliders are unstable particles due to their partial quantized mass which is generated from the smash process of the protons and neutron of the nuclei.

**VII- Electric Charge:** NMT supposes the magneton $m^{-1}$ rotates in a clockwise direction to generate the negative charge while the antimagneton $m^{+1}$ rotates in an anti-clockwise direction to generate the positive charge. The circular package is of a quantized mass of magnetons, $m^{-1}$ or $m^{+1}$, holds partial charge. The single magneton $m^{-1}$ or antimagneton $m^{+1}$ does not own an electric charge but only the magnetic property. NMT supposed that these magnetons are quantum particles rather than classic particles.

The spinning-rotating magnetons, in the circular package, create a tiny oscillating magnetic field $B$. A tiny time-varying $B$-field produces a beam of time-varying nano-current $I$ which is considered as a flow of minute differential ($\pm$) electric charge along the circular closed chains of the magnetons in quantized mass packages. This concept is based on Faraday’s Law (Maxwell–Faraday equation $\oint E \cdot dS = -\iint B \cdot \frac{\partial \ell}{\partial t} dS$). The magnetic moment $\vec{m}$ of such nano-current beam distribution in space might be found from the following equation-6:

$$\vec{m} = \frac{1}{2} \int r \times J \, dV$$

Here, $r$ is the position vector pointing from the origin to the location of the volume element, and $J$ is the current density vector at that location on the circular package of the magneton. The current density $J$ for any assembly of moving charges, such as a spinning charged solid can be given by $J = \rho V$, where $\rho$ is the electric charge density at a given point and $V$ is the instantaneous linear velocity of that point. The spinning-rotating magnetons behave like a rotating bar magnet. They produce magnetic dipole radiation because they rotate with high speed, i.e. $b$ speed. The magnetic dipole radiation is just like electric dipole radiation, but has a magnetic field $B$ in the plane of $r$ and an oscillating magnetic dipole, while electric dipole has an electric field $E$ in that plane. The spinning-rotating magnetons produce circular polarization along the axis of rotation and plane polarization perpendicular to the axis. The generated magnetic field lines configuration have nonzero magnetic helicity. An oscillating current in a circular loop of radius $b$ is a good model for an oscillating magnetic dipole. The generated current is of nanoscopic nature and it is inaccessible to direct observation, but it may produce net effects at discontinuities and boundaries. These nano-currents are called magnetization currents. For an oscillating magnetic dipole, the Poynting flux eq-7&8, which represents the directional energy flux density (watt/m$^2$), is

$$\mathcal{S} = \frac{1}{\mu_b} \vec{E} \times \vec{B} = \frac{1}{\mu_0 c} \left[ \frac{\mu_0 \omega^2 e^{i(k r - \omega t)}}{4 \pi c r} \right]^2 \left[ (\hat{r} \times \vec{m}) \times ((\hat{r} \times \vec{m}) \times \hat{r}) \right]$$

$$= \frac{\mu_0 \omega^4}{16 \pi^2 c^3} m^2 \sin^2 \theta \frac{e^{2i(k r - \omega t)}}{r^2} \hat{r}$$

where $k = \omega c = 2\pi/\lambda$, $\omega$ is angular frequency, $r$ is the radius, $\vec{m}$ is the magnetic dipole moment and $\mu_b$ is the magneton magnetic constant. The repulsion between the similar poles leads to spinning-rotation of the magnetons inside the fermion. The direction of the spinning and rotation of these dipole magnetons and antimagnetons will generate a beam of nano-current $I$ along their alignment which produces the negative or the positive charge on the quantized mass.
Diagram-2: The magnetons produce the (±) nano-current due to their spinning and rotation

The charged magnetic field is due to $\mu_b$

$$B = \frac{\mu_b}{4\pi} \int \frac{Idl \sin \theta}{r^2}$$

$$B = \frac{\mu_b I}{4\pi r^2} \int dl$$

$\Theta = 90, r \geq 2l_{B}$, $L = 2\pi R$. Here we used $\mu_b$ rather than $\mu_o$.

The Diagram-2 shows how the spinning-rotating magnetons generate a beam of nano-current $I$ in the circular closed quantized packages rings of radius $R$ moving around the fermions. The radius $R$ of the sphere of the proton and neutron has a range from $2l_B$ in (the bottom) to 0.7822 fm (in the middle) then to $2l_B$ in (the top). The magnetic field $B$ falls within the same plane of the rotation while the plane of the generated nano-current will fall perpendicular to the plane of the magnetic field. The value of this nano-current may be calculated from the Biot-Savart law as seen in the Diagram-2. The nano-currents following in the same direction attract each other. The nano-currents of the magneton $m^{-1}$ and the antimagnetron $m^{+1}$ is given by the following equation:

$$F_{ab} = \frac{3\mu_o}{4\pi r^4} \left[ (\hat{r} \times \vec{m}_a) \times \vec{m}_b + (\hat{r} \times \vec{m}_b) \times \vec{m}_a - 2\hat{r} (\vec{m}_a \cdot \vec{m}_b) + 5\hat{r} \left( (\hat{r} \times \vec{m}_a) \cdot (\hat{r} \times \vec{m}_b) \right) \right]$$

where $\hat{r}$ is the unit vector pointing from magneton $m^{-1}$ to the antimagnetron $m^{+1}$ and $r$ is the distance between them and the force acting on $m^{-1}$ is in opposite direction. The vector potential of the magnetic field produced by the magnetic moment $\vec{m}$ of the magneton is given by eq-10:

$$A(r) = \frac{\mu_0 \vec{m} \times \vec{r}}{4\pi r^3}.$$  \hspace{1cm} (10)

and the magnetic flux density is given by eq-11:

$$B(r) = \Delta \times A = \frac{\mu_b}{4\pi} \left( \frac{3r (\vec{m} \cdot \vec{r}) - \vec{m}}{r^5} \right).$$  \hspace{1cm} (11)

For the oscillating magnetic field $B$, due to its spinning rotation, the $E$ and $B$ might be expressed as follows:

$$B \approx -\frac{\mu_0 m \omega^2}{4\pi c^2} \left( \frac{\sin \theta}{r} \cos \left[ \omega \left( t - \frac{r}{c} \right) \right] \hat{r} $$

$$E \approx +\frac{\mu_0 m \omega^2}{4\pi c^2} \left( \frac{\sin \theta}{r} \cos \left[ \omega \left( t - \frac{r}{c} \right) \right] \hat{r} $$

$$\approx \frac{\mu_b}{4\pi} \left( \frac{3r (\vec{m} \cdot \vec{r}) - \vec{m}}{r^5} \right).$$  \hspace{1cm} (11)
These two magnetons $m^{-1}$ and $m^{+1}$ usually change their spin direction in the packages within the nucleons (p,n) in a harmonic manner that keeps the nucleon under constant stability. The magnetons are not their own antimagnetons thus, they are not Ettore Majorana particles but they are Dirac fermions. Diagram-3 shows that their spinning orientations are not identical. The difference between Majorana fermions and Dirac fermions is that they can be expressed mathematically in terms of the creation and annihilation operators of second quantization (for a Dirac fermion the operators $\gamma_j$ and $\gamma_j^\dagger$ are distinct, while for a Majorana fermion they are identical). In superconducting materials, Majorana fermions can emerge as (non-fundamental) quasi-particles. The magnetons will not follow creation and annihilation operators and they require new operators. The magneton and antimagneton cannot have the same direction of spinning when they change their spatial orientation because they are chiral. The parity transformation $P$ will flip the sign of all three spatial coordinates: $P = \begin{pmatrix} x \\ y \\ z \end{pmatrix} \mapsto \begin{pmatrix} -x \\ -y \\ -z \end{pmatrix}$. The quantized mass packages of the magneton $m^{-1}$ with a partial negative charge will be integrated and completed in the fermion as in the electron with elementary negative charge, while the quantized packages of the antimagnet $m^{+1}$ with a partial positive charge will be integrated and completed as in a proton with elementary positive charge. For example the electron is composed of 207045 magnetons $m^{-1}$ and $m^{+1}$ (based on mass of magneton which is supposed to be 0.25 eV) with unitary elementary negative charge. This NMT confirms that the proton and electron have only one specific quantized mass while the neutron has several quantized mass that depends on the host nuclide. For that reason only the neutron will share in the nuclear reactions calculation as shown in next items.

**VIII- Self-Nuclear Forces and Unified Field**

The high dense magneton $m^{-1}$ and its antimagnet $m^{+1}$ inside the fermion will create high gravity circular closed quantized packages rings of magnetic dipoles in the form of matrices. These two spinning-rotating magnetons create a **Strong Charged Electromagnetic Force (SCEF)** field of long range due to their own extraordinarily strong magnetic constant ($\mu_b=23\mu_o$). In addition to SCEF, they generate **self-gravity force (SGF)** in ultrashort range inside the fermions (a type of gravitational force) due to their high density $2.583969548 \times 10^{66}$ kg/m$^3$. These two forces SCEF and SGF create the **Strong Self-Nuclear Force (SSNF)** which represents nuclear energy. This fact led the NMT to realize that there is a **Gravitomagnetic Field**

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9 This value (207045 magnetons) can be modified when the nuclear measurement give the exact mass of the neutrinos. If the mass of the magneton is increased by 10 the number will be decreased by 10.

10 In this context, we can say that inside the nucleus the energy can be created by magnetons and dissipated in the universe during nuclear processes and reactions.

11 When the apple fell down Newton looked at the earth action, he did not look up to sky action; atmosphere pressure and magnetic field’s (magnetosphere). If the gravitational action is purely dependent on two body masses then why is the...
that is similar to the electromagnetic field which is generated from the mass gradient \( \mathbf{m} \) vector \((m_1, m_2)\) and the magnetic field \( \mathbf{B} \) vector of the magnetons \((m_1, m_2)\) inside the fermions. NMT believes that this field works at both nuclear and planetary systems due to the flexibility of \( \mathbf{B} \) and \( \mathbf{m} \). Some of this SSNF will be used as strong nuclear force (in comparison to gluon) to bind the magnetons packages inside the nucleon. The other part of the SSNF will be used as binding energy between protons and neutrons (in comparison to weak force) among the nucleons inside the nucleus in addition to the four-force carrier conservon \( \kappa \) particles (see item 2.2). It is stronger inside the nucleon than among protons and neutrons. Thence this SSNF covers the range of the weak and the strong nuclear forces. The SSNF forces represent strong nuclear forces, weak nuclear forces, electromagnetic forces and gravitational forces. Thus, it is considered as a force of Unified Field. The SMT theory stated that the strong nuclear forces rapidly decrease to insignificance at distances beyond 2.5fm which means that these forces cannot fix more than two adjacent nucleons, leaving the other groups of nucleons loose while the field of this SSNF forces has a long range that reaches the atomic orbitals.

These two magneton particles are responsible for building the matter and the anti-matter in our universe as they are available as long closed chains composed of packages of quantized mass size which build the fermions (\( e, p, n \)) and finally the atoms of the molecules. This NMT does not have a confidence in energy carriers. The reason for this belief is that the waves of energy move by self-sustaining field as the magnetic field generates the electric field and the electric field generates the magnetic field and so on\(^{12}\). From a logic point of view, if these waves need carriers of wave-nature, then these carriers’ further need carriers and this sequential is void, or if these carriers are of massive-nature then they cannot carry energy as they are heavier than the waves and cannot move with speed of waves. In that case, the energy carriers such as photons, bosons and gravitons are untenable and it is difficult to be understood\(^{13}\).

IX- Mass-Energy Conformity Principle: The momentum of the magneton quantity inside the fermion is given by \( p = mb \). The amount of the energy, SSNF, generated is expressed by \( E = mbc \) based on Mass-Energy Conformity Principle. This principle has three criteria which discuss the concept of the energy of the moving system which conforms to its moving mass.

First, in classical macro system, the kinetic energy of the moving mass, which is described by \( E_k = \frac{1}{2}(mv_1)v_2 \), the first velocity \( v_1 \) will be multiplied with the mass to give the momentum of the system while the second velocity \( v_2 \) is considered as a simple unit conversion factor to convert the momentum unit to joule unit. The calculated energy here is a mathematical function for that moving mass. This means that the essential issue in this term \( E_k = \mathbf{p}(\frac{1}{2}v_2) \) is the momentum \( \mathbf{p} \) while the other two factors (i.e. \( \frac{1}{2} \& v_2 \)) are trivial or insignificant as they do not have any physical meaning. The factor \( (\frac{1}{2}) \) is redundant and \( v_2 \) is unit conversion factor. This concept is a general rule for the calculation of mathematical kinetic energy for any moving mass in the macro system.

Second, in quantum micro system, the kinetic energy of the moving mass, which is described by \( E = (mb)c \), the \( (mb) \) term represents the momentum and the second speed \( c \) is considered as a simple mathematical unit conversion factor to convert the momentum unit to joule unit. This concept is applied to the all moving non-accelerated particles such as neutron, proton and electron and fission product heat (Q-value). This concept is a general rule for the calculation of mathematical the kinetic energy for any moving mass in quantum micro system.

Third, in the fermionic atto system that is composed of spinning-rotating magnetons, which are described by \( E = (mb)c \), where the second speed \( c \) is a conversion factor and its multiplication with
momentum (mb) will give the real amount of the energy which will be generated due the spin-rotation of the magnetons inside the fermion. The non-relativistic mass-energy equivalence $E=mbc$ gives 194.177 MeV/bc to one atomic mass unit $u$.

Based on **Mass-Energy-Conformity Principle**, the amount of the energy created or released from the fermion is equivalent to the summation of the mass of the spinning-rotating magnetons. According to this concept, the magneton or its anti magneton will generate 0.0523 eV E/bc (or 0.25 eV E/c² for purpose of comparison with the literature) inside the fermion. When these packages of magnetons leave the fermion texture, during nuclear processes, they will carry this energy to the environment as gamma rays and they finally disintegrated to single magnetons (or $\nu_e$). In NMT, all the nuclear activities calculated are based on this principle. The overall surplus of the strong self-nuclear forces SSNF will create an **outer charged electromagnetic shell**, OCEM-shell (columbic field) around the nucleus. The OCEM shell protects the nucleons: to not run away from the nucleus, to control their stability in regard to the disintegration, to assign the effective radius, and to control binding the electrons in quantized orbitals. This OCEM shell will be torn at very high temperatures in the stars which let the nucleons to be free for a short time to fuse to create new nuclides. The OCEM (columbic field) is behind the fuzzy surface of decreasing nuclear density.

**X- General Function Description:** These magnetons can be described mathematically by an eight-parameter function $\Psi(x, y, z, t, p, f_e, f_p, f_n)$: where x-y-x-t stand for space-time coordinate, $p$ stands for momentum operator (mb), $f_e$ stands for electromagnetic operator, $f_g$ stands for gravitational operator and, $f_n$ stand for nuclear force operator. These functions exist in an 11-dimensional universe (11D); 3D-space (x, y, z), 1D-time, 2D-momentum (mass, b-speed), 1D-matter nature (magneton $m^{-1}$, antimagnetron $m^{+1}$), and 4D-force fields ($f_g, f_e, f_w, f_n$) which stand for gravitational, electromagnetic, weak, and strong force field respectively. The quantum mechanical model and its treatment for these magnetons in the fermions will be derived and published in a separate paper. The final mathematical solutions for this model have to give energy values identical to the proposed values of the Mass-Energy-Conformity Principle.

### 2.2. The Four-Force Carrier Conservons

NMT considers the **conservon** $\kappa$ particles plays a major role in controlling the nuclear properties of the protons and neutrons and in binding them inside the nucleus similar to the Yukawa $\pi$-mesons (pions)⁵⁶, which were reported in 1934. These **conservon** $\kappa$ particles also play a major role in controlling the conservation of mass number, linear momentum, total energy, charge, and spins during the nuclear reactions. The partial quantized mass of this **conservon** $\kappa$ can be calculated from time-energy relation $\Delta E \Delta t = \hbar$, which is mathematical theorem as well as physical statements, and the non-relativistic quantum mass-energy equivalence $E=mbc$ as follows:

The **conservon** $\kappa$ is very heavy and cannot move with the speed of light. Consequently, we will use this universal particle speed constant $b$ for **conservon** $\kappa$ mass calculation. This NMT assumes that the proton and the neutron are existed in fixed places inside the nucleus and it supposes also that the nucleus is consisting of several spheres distributed in hypothetical nuclear shells and each sphere is filled up with four nucleons i.e. two protons and two neutrons. (When there are insufficient nucleons, the sphere may have 3 or 2 or one nucleon. See item 5). The **conservons** $\kappa$ are of partial quantized mass texture that keeps the four nuclear forces between any two particles p-p, n-n, p-n of these four fermions at stable energy states. They also hold a certain partial charge of different magneton’s matrices to keep the nucleons textures in their quantized mass.

There are two types of **conservons** $\kappa$. The first type of **conservon** $\kappa$ moves between two similar nucleons, i.e. p-p and n-n, while the second type moves between two different nucleons, i.e. p-n or n-p. The first **conservons** $K_{s}$ ($s=\text{similar}$) has to move a distance which equals approximately the diameter $j$ of the sphere while the second **conservons** $K_{d}$ ($d=\text{different}$) has to pass the z distance (i.e. $z=0.8197j$) of the sphere. This model is a primitive geometrical model. It supposes the size of the proton and neutron are spherical and identical but the proton is heavier than the neutron. The cross section of this model gives the geometrical parameters $j=12.2$ ($=2r$), $z=10$, $k=7$, $x=2.5$ as seen in the Figure-1. This
model estimates the radius of the proton or neutron to be 0.7822 fm. This value is closer to 0.74±0.24 calculated by Hofstadter, 0.8 fm\(^{14}\), 0.875 fm\(^{58}\) and to 0.84184 fm\(^{59}\) but far from 1.1133 fm\(^{60}\) and 1.535fm\(^{15}\). In the next following paper, we will calculate the mass of these conservons from the theoretical methods. The radius of this sphere can be calculated from the density \(\rho\) and the volume \(v\) of sphere where \[ \rho = \frac{m}{v} \quad and \quad v = \frac{4}{3} \pi r^3 \] as follow:

\[ \rho = \frac{m_{2p+2n}}{v_{2p,2n}} = \frac{(2m_p + 2m_n)}{\left(\frac{4}{3} \pi r^3\right)} \]

which gives \( r^3 = \left(\frac{3(2m_p + 2m_n)}{4\pi \rho}\right) \) \( (14) \)

The density of this sphere is supposed to be equal to the density of the nucleus\(^{16}\) 2.3x10\(^{17}\) kg/m\(^3\) (or 200,000 metric tons/mm\(^3\))\(^{61}\). The mass of free neutron has been used in the calculation of the mass of the conservon \(\kappa\). The calculated mass of conservon \(\kappa\) has to be constant even if the neutron mass is varying in different nuclei because any change in this mass will change the sphere diameter as seen in the density equation. The mass of this sphere can be calculated from summation of the mass of n and p as follow. Where \(M_n=1.6749274 \times 10^{-27}\) kg, \(M_p=1.6726218 \times 10^{-27}\) kg, the total mass and volume of this sphere can be given from the following formula.

\[ = \text{the mass of two protons and two neutrons} (m_{2p+2n}) \quad (=6.69509826 \times 10^{-27} \text{ kg}), \text{ which is very close to alpha mass} \quad 6.6446567 \times 10^{-27} \text{ kg} \]

\(v_{\text{spheres}} = \text{the volume of the sphere that include these two protons and neutrons} (v_{2p,2n})\) can be given by \((4/3) \pi r^3\). The calculated value of radius \(r\) of this sphere is equal to 1.9 fm \((1.9083008 \times 10^{-15} \text{ m})\)^\(^{18}\), which very is close to 1.89 fm \((1.9083008 \times 10^{-15} \text{ m})\)\(^{62}\), but it is a little bit greater than the radius of alpha particle 1.6 fm calculated by Hofstadter in 1956\(^{57}\). The value of the diameter \(j\) is 3.82 fm \((=3.81660164 \times 10^{-15} \text{ m})\)\(^{19}\).

A The mass of conservon \(\kappa\)

The time \(t\) required for conservon \(\kappa\) to pass this diameter \(j\) can be calculated from

\[ t=\text{distance/speed} = j/b; \]

or \(t= \left[3.8166016 \times 10^{-15} \text{ m} / 0.625 \times 10^8 \text{ m/s} \right] \)

or \(t=6.1071258 \times 10^{-23} \text{ s} \) (or 0.61 ys)\(^{20}\).

This is the time required by conservon \(\kappa\) to pass the distance \(j\) between two p-p and n-n in the sphere of our nucleons. Based on the mathematical theorem \(\Delta E \times \Delta t = \hbar\)\(^{63,64}\), the mass of this conservon \(\kappa\), which binds p-p and n-n can be given by:

\[ [\text{mb}^2 \times t]=\hbar ; \]

or \([\text{mb}^2 \times 6.1071258 \times 10^{-23}] = \hbar\), which will give the mass of the conservon \(\kappa\):

\[ m_\kappa = [1.054589 \times 10^{-34} \text{ J.s} / \left(6.1071258 \times 10^{-23} \text{ s} \times (0.625 \times 10^8 \text{ m/s})^2\right)] \)

or \(m_\kappa = 4.4214675 \times 10^{-28} \text{ kg} \) or \(m_\kappa = 485.3672509 \text{ me}\) (that means the mass of the conservon \(\kappa\) is 485 greater than mass of electron, \(m_e\)).

\(^{14}\) http://www.physlink.com/Index.cfm

\(^{15}\) http://www.paradox-paradigm.nl/?page_id=77

\(^{16}\) Different values in the literature has been mentioned for the nuclear density which is ranged from 1x10\(^{17}\) - 4x10\(^{17}\) kg/m\(^3\)

\(^{17}\) http://physics.nist.gov/cgi-bin/cuu/Value?mal|search_for=atomnuc!

\(^{18}\) Alpha radius is usually 1.2 fm, see Blatt & Weisskopf, Theoretical Nuclear Physics, Wiley, NY, 1952, p357.

\(^{19}\) NMT supposes the range of the weak nuclear forces happen from the end to end of the nucleon to cover all parts of the nucleon as seen in Fig-1 while the SMT supposes the range from the center to center of the nucleon.

\(^{20}\) ys= yocto second = 10\(^{-24}\) s
Figure-1: The sphere of two protons and two neutrons inside the nucleus and their K\(_s\) and K\(_d\) transfers among p-p and n-n and K\(_d\) transfers between p-n

Each sphere has 2p+2n

B The mass of conservon\(_d\) K\(_d\)

The mass of conservon\(_d\) K\(_d\) which binds p-n and n-p has to pass the distance \(z\) is equal to 0.8197j or equal to 3.1284684 \(\times 10^{-15}\) m can be calculated from the following equations. The required time to pass the \(z\) distance between p-n will be calculated as follow:

\[
t = \frac{[3.1284684 \times 10^{-15} \text{ m} / 0.625 \times 10^8 \text{ m/s}]}{0.625 \times 10^8 \text{ m/s}} \tag{18}
\]

or \(t = 5.006011 \times 10^{-23}\) s (or 0.5 ys). The mass of conservon\(_d\) K\(_d\) can be calculated as follow:

\[
[m_b^2 x t = \hbar] ; \tag{19}
\]

\[
[m_b^2 x 5.006011 \times 10^{-23} \text{s} = \hbar] , \text{ which will give:}
\]

\[
m_d = \left[ 1.054589 \times 10^{-34} \text{ J.s} / \{ 5.006011 \times 10^{-23} \text{s} x (0.625 \times 10^{8} \text{ m/s})^2 \} \right] \tag{20}
\]

or \(m_d = 5.394007 \times 10^{-28} \text{ kg}\)

or \(m_d = 592.12792 m_e\) (that means the conservon\(_d\) K\(_d\) is 592 greater than mass of electron, \(m_e\))

We may conclude that the mass of conservon\(_d\) K\(_d\) between proton-neutron is 592m\(_e\) (with average lifetime 0.5 ys) is heavier than the conservon, K\(_s\) between p-p, n-n 485m\(_e\) (with average lifetime 0.61 ys) due to the asymmetry of p and n textures. This result might explain why alpha nuclide is more stable than other nuclides due to having both K\(_s\) and K\(_s\). When the sphere has two nucleons (like \(^2_1\) D) or has three nucleons (like \( ^3_1\) H or \( ^3_2\) He), the mass of the two conservons (K\(_d\) and K\(_s\)) will become equal. They both only have to pass \(z\) distance (0.8197j) only and the mass of conservon is equal to 592m, with average lifetime of 0.5 ys.

The conservons \(\kappa\) function is to conserve the charge over mass quantization in neutron and proton textures inside the nuclei and when they bind each other and to help in conversion the proton to neutron and vice versa during the nuclear decay processes. The conservons \(\kappa\) are composed of certain of circular package of magnetons and they might be considered as four-force particles. They move through the n-n, p-p and n-p textures to quantize them in order to stabilize them. The conservons \(\kappa\) will fail to bind the protons and the neutrons when the neutrons cannot achieve the quantized mass (as we will see in later items) i.e. when the ratio of Z/N is high or N/Z is high. The mass quantization principle is the dominant factor in the nuclei stability and there is no randomness in the radioactivity process as we will see in item-3.3. When we plot \(\beta\)-energy KeV versus mass quantization \(u\) for any isotope, we will get a slope (keV/u) which explains that decay process is quantized.

2.3. Fermions Structure and Mass Quantization

The structure of the fermion particles and their antiparticles grows hierarchically from these high gravity circular closed quantized packages rings of magnetic dipoles under drastic circumstances in stars. This process starts when a huge numbers of magnetons \(m^1\) and antimagnetons \(m^{1+}\) compacting under SSNF (SCEF and SGF) as circular closed quantized packages rings. The superposition of these quantized circular rings causes the formation of the first quantized mass fermion, i.e. the electron of
quantized mass with unitary elementary negative charge (outside the nucleus). These quantized mass circular rings then merge further into a continuous hierarchy to form the larger unstable massive nuclear particles with partial quantized mass such as muon, pions, kaons and eta mesons then reaching the stable quantized mass fermion, such as the proton and the neutron (in stable isotopes only) then passing to heavier unstable particles like tau etc.

NMT gives a different story for the origin of the elements than Alpher-Bethe-Gamov (\(a-\beta-\gamma\) theory) or big-bang theory\(^{21}\). The NMT proposes that, in the stars, the electrons and the protons created from magnetons (\(m^{-1}\) and \(m^{+1}\)) first as being highly stable fermions, and then several of the protons will convert to quantized neutrons \(n^*\) (not free neutron \(n\), see item-2.5) during severe nuclear fusion reactions to form various nuclides (nucleosynthesis). Two of four protons will fuse to form \(^4\)He \((2p+2n^*)\) nuclide, \(E_f^o=24.687\) MeV where 2p are converted into 2\(^n^*\) and 2e\(^+\) and also 4p of each eight protons will fuse to form the unstable \(^8\)Be \((4p+4n^*)\) nuclide, \(E_f^o=49.282\) MeV, \(t_{1/2}=6.7\times10^{-17}\) s, (and possibly \(4x^2D\rightarrow\) \(^8\)Be, \(Q=47.6\) MeV) which will split to emit two \(^4\)He and so on to form diverse nuclides (see Item 4.7 for standard energy of formation of nuclide \(E_f^o\)). If the free neutrons cannot share the protons to create more nuclei they will be decayed after 881.5 s. Among these particles only protons and electrons are stable in free space. The generated electrons immediately bind the bared nuclei (in non-plasma regions) to form the nuclides. When the magneton packages cannot share these quantized circular packages in the fermions, they will be ejected from the fermions as a package then disintegrated to single magnetons (or \(\nu_e\)) and they will lose the nuclear force property but retain spin. All other types of neutrinos like muons and tau neutrinos come from these flying packages of magnetons of different masses which are unstable and finally will be disintegrated into single magnetons (or \(\nu_e\)).

\(\text{Diagram-4: The Nmtionic Shells of the Electron, Proton and Neutron}\)

In the outline of this theory, based on \textbf{Mass Quantization Principle QMP}, the NMT suggests that these circular closed quantized packages rings are arranged in a certain way to build the fermion through formation of \textbf{quantized nmtionic shells}. Both the electron and the proton textures have three nmtionic shells 1\(^{\text{st}}\) K, 2\(^{\text{nd}}\) L, and 3\(^{\text{rd}}\) M while the neutron texture has four quantized nmtionic shells 1\(^{\text{st}}\) K, 2\(^{\text{nd}}\) L, 3\(^{\text{rd}}\) M and 4\(^{\text{th}}\) N. Hence the neutron will be heavier and larger than the proton when it is free only but of equal size inside the nuclei as seen in Diagram-4. All these main nmtionic shells have quantized subshells. The 1\(^{\text{st}}\) K shell is the densest; therefore, it is considered as a core and center of mass of the fermion particle. The magnetons \(m^{-1}\) spinning-rotation of these circular closed quantized rings in the three nmtionic shells generate the negative charge in the electrons and the antimagnetons \(m^{+1}\) spinning-rotation generate the positive charge in the proton shells while the net charge of these four nmtionic shells in the neutron is zero. The charge radii for these three fermions are not fixed due

\(^{21}\text{The old big-bang theory of Gamov and his student Alpher in 1948 postulated that in the beginning of our universe all matter in it existed as neutrons in some supergiant nucleus which exploded. During the explosion neutrons were converted to protons through beta decay. The protons and the neutrons combined together to form the heavier elements.}\)
to the elasticity structure of the nmtionic shells. The charge radii are liable to any change when they expose to magnetic or electromagnetic fields.

In the neutron texture, these magnetons (magneton $\mathbf{m}$, antimagneton $\mathbf{m}^*$) circular closed quantized packages rings generate partial negative charges in core $1^{\text{st}}$ K and the outer $4^{\text{th}}$ N shells and partial positive charges in the two middle nmtionic shells $2^{\text{nd}}$ L and $3^{\text{rd}}$ M provided that the charges of the magnetons of the circular rings in $1^{\text{st}}$ K and $4^{\text{th}}$ N complete the unitary elementary negative charge and in $2^{\text{nd}}$ L and $3^{\text{rd}}$ M complete the unitary elementary positive charge. The net charges of these four nmtionic shells have to be zero in the neutron texture. The partial positive charge of middle shells $2^{\text{nd}}$ L and $3^{\text{rd}}$ M of the neutron pushes protons and neutrons apart before they can get close enough to touch. This shell texture diversity is responsible for the electric dipole moment, electric polarizability, magnetic polarizability, and negative magnetic moment of the neutron. The variety of the different spin-rotation direction of the magnetons of the four shells lead to a negative value of magnetic moment $-1.04187563 \times 10^{-3} \, \mu_B (= -1.913 \, \mu_N)$, while the spin-rotation direction of the magnetons of the three nmtionic shells of the proton enhance each other to give the $1.521032210 \times 10^{-3} \, \mu_B (= +2.793 \, \mu_N)$ even they are so far between each other. In the electron, the three shells give the $-1.00115965 \, \mu_b$ because these shells are very closer to each other which enhance the charged electromagnetic field. The minus sign indicates that the neutron or the electron's magnetic moment is antiparallel to its spin. The electron nmtionic shells are behind Casimir effect where physical forces arising from a quantized field.

NMT expects that the middle shells $2^{\text{nd}}$ L in the electron and in the proton might reverse its spinning-rotation direction (in some types of nuclear reactions), to change the partial charge, under high magnetic field to produce neutral electron $e^0$ and neutral proton $p^0$. With advanced technological facility of $e^0$-beam, it will be used for treatment of cancer cell without affecting the other tissues. Both $2^{\text{nd}}$ L and $3^{\text{rd}}$ M shells in the neutron also might reverse their spinning-rotation direction (in some types of nuclear reactions, where there is low N/Z or Z/N), to change the partial charge, to produce a neutron with positive and negative charges $n^\pm$ of short half-life which expected to be less than $10^{10}$ sec as intermediate stages.

The neutron partial negative charge in the outer $4^{\text{th}}$ N shell will attenuate slightly the positive charge of the outer $3^{\text{rd}}$ M shell of the pairing proton, inside the nuclear shells in the nucleus, through formation of moderate nmtionic bonds in addition to the four-force conservons $\kappa$ action. This attenuation is behind the pairing energy effect. Both the charged electromagnetic field of the four nmtionic shells of the neutron and the electrons screening effect will affect the total value of Z of the isotope. Thus, the frontier electrons will feel with the so-called the effective atomic number $Z^*$ that make little differences in bond energy and bond length of the isotopes in their compounds[65]. **These neutronic and electronic factors and the isotopic mass variance result in what is known as isotopic effect**[22]. NMT thinks the strong magnetic field will affect the nmtionic shells charged EM that enhance the difference among isotopes physical properties. The forces among these three fermions i.e. electron, proton and neutron, usually happen through the interaction of the outer nmtionic shells $3^{\text{rd}}$ M of the electron and proton and $4^{\text{th}}$ N of the neutron. The action of the proton columbic forces on the electron in the atomic orbitals of hydrogen atom takes place mostly through the interference of the charged electromagnetic forces of the three nmtionic shells due to the motion of the magnetons in these nmtionic shells in proton and electron. Other than in the H atom, in the nuclei, the OCEM shell controls the atomic orbital electrons attractions.

Due to this nmtionic shell’s flexibility, NMT supposes that the two neutrons either behave like electrons in atomic orbitals to have opposite paring spin (singlet state) to follow the Pauli principle, especially in lighter stable nuclides, or the partial negative charge of the $4^{\text{th}}$ N shell and partial positive charge of $3^{\text{rd}}$ M of one neutron may exchange to make the outer $4^{\text{th}}$ N shell positive to form strong

---

[22] If the electrons completely control the screening effect then the isotopes should have the same physical properties as they have the same number of the electrons. The isotope effect includes freezing & boiling points, density, heat of vaporization, viscosity, surface tension, etc. The author had wrote an iterative program in 1992 to carry out few millions iterations to calculate $Z^*$. Quantum Defects D and Screening Constants S for all periodic elements and his results were very close to Clementi and Slater.
nmntionic bond to bind the partner neutron of the similar spin (triplet state) to violate the Pauli principle, especially in heavier unstable nuclides.

The neutron partial negative charge in the outer $4^{th}$ N shell also highly facilitates the entrance of the thermal neutron to the nuclei of heavy nuclides since the OCEM forces will accelerate the neutron toward the nuclei. These partial negative charges, $1^{st}$ K and the outer $4^{th}$ N, of the two neutrons in the alpha particle also help in the penetration of the alpha particle to pass the potential barrier of the nucleus more easily. Due to the coulombic attraction between the partial positive and the partial negative nmntionic shells of the nucleons in both in the nuclei and alpha which is commonly interpreted by alpha tunneling quantum effect.

When the neutron get an extra mass from these magnetons’ packages, during its formation in the stars or through nuclear reactions and decay processes, it will become unstable due to the superfluous unquantized mass; and the neutron magnetons will be excited and will affect the textures of the four nmntionic shells of the neutron which will lead to beta decay. The greater the unquantized neutron’ mass of a nuclide, the shorter the half-life. These beta decays will be accompanied with instant gamma rays or X-rays emissions or both depend on the mass of the magnetons released. The heavier the magnetons’ packages released, the higher the gamma-rays radiations emitted and the lighter the magnetons packages released, the lower the gamma-rays or X-rays radiations.

The proton can form nmntionic bonds when it changes the direction of the spinning of the magnetons of the outer $3^{rd}$ M nmntionic shell to have anti spin to form weak attractive nmntionic bonds in diproton p-p ($^{2}$He). When the proton acquires enough energy from its environment (excited nucleus), it will convert to neutron to form $^{2}$D and emit positron. The n-n nmntionic bonds is stronger than p-p nmntionic bonds as seen in $^{3}$H or $^{2}$He.

On the contrary, when the N/Z ratio becomes too low, the proton texture will endure a nmntionic shells rearrangement to emit positron or will captivates an electron from the inner atomic orbital to convert to a neutron with help from conservons $\mathbb{Q}$. These processes will be accompanied with gamma-rays and X-rays radiation.

In the atomic orbital interactions, the visiting electron changes the direction of the spinning of the magnetons of the outer $3^{rd}$ M nmntionic shell mainly to have opposite spin to occupy the same orbital of its hosting electron. The change process, which takes place in $3^{rd}$ M shell of the electron, requires a small energy from the system; thus it is endothermic process. This process is known as pairing energy or Crystal Field Spin Energy (CFSE) which is the energy required to accommodate two electrons in one orbital granted by the ligand. The opposite directions of the outer $3^{rd}$ M shells in the two pairing electrons will set up a charged electromagnetic nmntionic bond (as in singlet state) that causes a paired state of electrons to have a lower energy than the Fermi energy. The nmntionic bond leads to the stabilization of the chemical system, even at zero Kelvin, because the magnetons are in continuous spin-rotation at such temperature. The charged electromagnetic nmntionic bond can explain the Meissner effect (an expulsion of a magnetic field from a superconductor) and Cooper pair or Bardeen-Cooper-Schrieffer theory, BCS Theory, of the superconductivity in superconductors. The electrons of similar spin will form antinmntionic bond (as in doublet and triplet state) which lead to the destabilization of the chemical system.

Not only do the electrons form nmntionic bonds at zero Kelvin but, also, the neutrons and the protons can form them. Thence, we have four nmntionic bonds, i.e. electron-electron, neutron-neutron, proton-proton, and neutron-proton.

When the electron is exposed to magnetic or electromagnetic field, it interacts with that field energy (such as the photoelectric or Compton’s Effect), and the magnetons of nmntionic shells will interact with these electromagnetic waves through interference. They will be excited and the nmntionic shells will be expanded and the electron position will be shifted up; then it will radiate energy to reach its ground state. This mechanism negates Heisenberg Uncertainty principle, and Einstein explanations of the photoelectric, and Compton’s effect which is based on the photon impact.
The flexibility of the textures of the fermions gives them a gelatinous form, elasticity. It also grants them the apparent so-called dual wave-particle character. De facto there is no particle-wave duality concept but the fermions show this property due to their charged EM aura as being formed by spin-rotating magnetons.

NMT has different explanation to the De Broglie formula. NMT understands that the Louis De Broglie equation \( \lambda = \frac{\hbar}{p} \) is more specific to the fermions which have EM aura, whether a charged EM aura as in electron and proton or neutral EM aura as in neutron etc. The \( \lambda \) here represents the wavelength of charged EM aura of the fermion rather than the mass of the fermions. NMT suggests an alternative effective formula \( \nu = \frac{mbc}{h} \) to indicate the frequency of the charged EM aura of the fermion. When mass of the fermion increases, that means the more magnetons will create a stronger charged EM aura. This texture gives also the atoms and the molecules the wave property like diffraction, interference, and reflection.

Changes occur in the proton, neutron and electron textures as a result of reorientation and rearrangement in the nmtionic shells’ configuration, which are caused by any decay process. These changes will lead to low energy radiation that ranges from IR and Vis-ultra-violet to X-rays regions, which share the background radiations. For example, when the magnetons’ package (500-2500 magnetons), let us say 1000 magnetons, get excited due to any process, the frequency \( \nu \) of its radiation will be \( 1.34 \times 10^{16} \) Hz based on \( \nu = \frac{mbc}{h} \) which falls in ultra-violet regions. Such excitation happens to the proton, neutron, and electron textures in the reactor and the excitation process leads to a brilliant blue radiation. This phenomenon is known as Cherenkov radiation.

SMT attributes the Cherenkov radiation to polarization of the medium by the high speed charged particles which exceed the phase velocity of light (0.7c) and follows Frank–Tamm formula\(^{[71,72]} \). NMT considers SMT mechanism to be unsatisfied\(^23 \). NMT believes that the excitation occurs through two path ways; first, when the released energetic magnetons impact the magnetons packages of the p, n, and electron textures through probabilistic peer impact mechanism (i.e. likes impact likes)\(^24 \) and second, when electron nmtionic shells undergo excitation due to collisions with cooling system in the reactors. The excitation frequency of this process falls in the IR and Vis-ultra-violet region.

This phenomenon happens to the electron, proton and neutron textures in severe circumstances. For example, the sun showers particles, including high energy packages of magnetons (\( \nu_e, \nu_\mu \), and \( \nu_\tau \) neutrinos), collision with the upper layers of atmospheric atom’ electron and nuclei will also result in Cherenkov radiation, which also shares Rayleigh scattering, to create the blue color of the sky.

The quantized mass particles like electron, proton or neutron are stable only in the ground state and have eigen-value and eigen-state. In the colliders, any particle formed inside the nucleus with unquantized mass in the ground state will be disintegrated to reach the quantized mass particle. In that case, the formed particles (except the proton) are of a definite flavor but do not have a definite number of magnetons ratio to give an exact quantized mass. Rather they exist in a superposition of quantized mass of quantum mechanical eigen states. This means the number of magnetons in each formed particle (except the proton) may vary in the total numbers of magnetons in their quantized mass which are affected by the total number of the protons and the neutrons and the OCEM-shell in that specified nucleus of that element and its isotope.

NMT assumes the electrons are distributed in atomic orbitals and their densities might be described by the mathematical functions (s, p, d, f, g), but they are in non-circulating (semi-stationary) states bounded to the cumblic field of the OCEM shell of the nucleus. This cumblic field makes them spin at their local positions. Consequently they can be described by 3D local density

\[
\frac{dE}{ds} = \frac{q^2}{4\pi} \int_{\nu=\nu_{min}} \mu(\omega) \omega (1 - \frac{c^2}{v^2 + \omega^2}) d\omega
\]

\(^{23}\) The total amount of energy radiated per unit length follows Frank–Tamm formula

\(^{24}\) Probabilistic Peer Impact Mechanism describes the manner of the reaction of the energetic magnetons with its peer magnetons of the fermions. The magneton-magneton peers impact each other which result in excitation of the fermion body without using W and Z bosons mechanism.
Nuclear Magneton Theory of Mass Quantization "Unified Field Theory"

mathematical functions. This atomic orbital structure model is different than that of Niels Bohr model.\(^{25}\)

2.4. Nucleons Spallation Reactions

When the proton and the neutron in the nucleus undergo any induced nuclear reaction through bombarding with e, p, n, α, etc., these bombarding particles will impact the nucleons to tear their nnionic textures which results in the creation of different fragment products (different magnetons packages). These products are known by muon neutrino \(\nu_\mu\), tau neutrino \(\nu_\tau\), electron e, muon \(\mu\), tau \(\tau\) and mesons which are more than 120 particles (pions, kaons, Eta, K, D B mesons etc.) including their anti-particles etc. Some of texture of magnetons will be emitted from the nucleus as unquantized mass particles which will release gamma and X-ray energy to the environment during the disintegration to single magnetons (neutrinos \(\nu_e\)). These phenomena were previously interpreted as neutrinos oscillations by Bruno Pontecorvo and Mikheyev-Smirnov-Wolfenstein (MSW).

In stars and reactors, the magnetons of high energies will impact the quantized circular packages of magnetons of p and n to induce fission reactions, especially with heavy nuclei, in a manner analogous to that of neutrons with nuclides of heavy elements. These magnetons also collide with the electrons of the material to excite its quantized circular packages of magnetons due to the high energy. When the magnetons’ packages of high energy attack the nuclide, they will collide elastically with the magnetons \(m^{-1}-m^{+1}\) textures of protons and neutrons which result in big shaking in the texture of e, p and n of the nucleus that finally radiate the absorbed energy in UV region as Cherenkov radiation. This collision occurs through Probabilistic Peer Impact Mechanism due to their equal mass. There is a low competition ratio between magnetons and neutrons attacking the fissile nucleus in nuclear reactors, which enhance gamma rays that increase sum of released energies beyond the estimated Q-value. The attacking of the magneton packages to fission products will increase their neutron masses. Such system thermodynamically is called an open system (see Items-3.6 and 4.7). The cold single magnetons (neutrinos) in the atmosphere are inactive as our body receives harmlessly approximately 50 trillion magnetons per second.

The reaction of hot magnetons with fermion’s textures cannot be explained based on the quarks concept as these attacking magnetons will not have enough momentum (on mass scale, the ratio of quarks/ magnetons/ is ca. 1/1\(^{-7}\)) to impact the quarks of the fermions. Based on this magneton theory, we can say that these attacking magnetons packages have the similar mass to the magnetons of the fermion’s texture and they have the high probability to react together.

NMT assumes that any nuclide or isotope will emit specific circular packages of magnetons which can be detected as a specific spectrum of magnetons (of certain mass and energy) that can be considered as finger prints for that nuclide. Besides, in the reactors, any type of nuclear reaction will emit its own definite spectrum of magnetons (or \(\nu_e\)) which is a highly specific probe for discovering the type of nuclear activities. For example, the beta decay can be written in this way:

\[
\sum_{\text{Four }} \text{car}^{-1} + e^- \sum_{m^{+1}} m^{+1} (or \nu_e) \qquad (21)
\]

\(^{25}\) NMT suspects the superseded Bohr model which is highly affected by the solar system at that time where positively charged nucleus surrounded by electrons that travel in circular orbits around the nucleus. Bohr used linear momentum rather than angular momentum to determine the electron's total energy

\[
E = \frac{1}{2} m v^2 + \frac{Z e^2}{r}
\]

succeed in explanation of hydrogen spectra. The Bohr model which included linear momentum endorses NMT concepts that the electrons are in stationary states which exist as a cloud of probability and that they jump up and down during excitations. This idea confirms the certainty in the measurement because the electromagnetic field of the measuring system will overlap with electromagnetic of the magnetons of the electrons to give accurate values for the position and the momentum of the jumping electrons. The atomic electrons absorb a wide spectrum of the surrounding energy and emit the corresponding energies as atomic, molecular and thermal spectra. If the electrons are really in continuous circulation then we cannot explain the chemical bonds such H-H in clear idea because the two bonding electrons cannot circulate around the two nuclei.
where sigma indicates to the specific package of antimagnetons (or antineutrinos) emitted from that neutron. The \( \beta \)-decay of any source will be affected by the density of existence of energetic magnetons around the source whether in the nuclear reactors or in stars. This type of reaction might affect the abundance of the isotopes in the universe. The \textit{conservon} \( \sigma \) is responsible for the transmutation of the neutron to the proton through changing the texture of the four neutron nmtionic shells to three nmtionic shells of the proton.

2.5. Particle and Antiparticle Stability

The stability of the particle and antiparticle may be discussed from four main criteria points of view based on the concept of this NMT theory. The first criterion is the number of packages of magnetons in that particle which reach the quantized mass (QM). The second criterion is the quantity of the partial charge held by this number of the packages. The third criterion is the value of the ratio of \( m^+ / m^- \) inside the particle or the nucleon. The fourth criterion is the type of magnetons matrix which creates the final spin and parity. These four criteria will control the particle to give the final charge, magnetic moment, spin to the particle and other required quantum properties.

The first criterion states that the number of packages of magnetons in the electron and the proton is fixed and has quantized mass \( QM_e \) and \( QM_p \), so they are stable anywhere except in a severe environment. The neutron has several quantized \( QM_n \) masses which depend on the stable nuclide of that element. The \( QM_n \) is defined as the mass of neutron in the stable isotope of that element. The value of \( QM_n \) in the stable isotope is calculated from this formula \( (M_A-ZM_n)/N^{26} \). When the number of packages of magnetons is increased in the neutron of any isotope of that element and exceeds the quantized mass \( QM_n \) of its stable isotope, the isotope becomes radioactive and we say its neutron has unquantized mass, \( UQM_n \). Therefore, we can say the \( QM_n \) is available in stable isotopes and that \( UQM_n \) is available in radioactive isotopes.

For example, the neutron has one quantized mass \( QM_n \) in fluorine, \( ^{19}F \)-isotope, and has three quantized masses in oxygen i.e. \( ^{16}O \), \( ^{17}O \) and \( ^{18}O \) and ten quantized masses in tin i.e. \( ^{112}Sn \), \( ^{114}Sn \), \( ^{115}Sn \), \( ^{116}Sn \), \( ^{117}Sn \), \( ^{118}Sn \), \( ^{119}Sn \), \( ^{120}Sn \), \( ^{122}Sn \), \( ^{124}Sn \), and so on.

The second criterion states that the particle with negative charge requires fewer packages of magnetons to achieve the unitary elementary negative charge like the electron, while the particle with positive charge requires more packages of magnetons to achieve the unitary elementary positive charge like proton. The free neutron always has the texture of the magnetons matrix that covers proton texture and electron texture to achieve the neutrality of the charge. Consequently, it is impossible to have a stable antiproton (with negative charge) or antineutron. The same thing can be said for all antimatter of positive or negative particles.

The second criterion also discusses the charge over mass ratio (c/m). The ratio of charge over mass (c/m) of the provisional particle will determine the degree of its stability and the sensitivity to the magnetic field. The electron and the proton are considered as references for comparison due to their charge quantization (i.e. their packages of magnetons complete the unitary elementary negative and positive charge). The tau' particle has shorter half-life than muon' due to a large mass of tau' (i.e. low c/m) in comparison with that of muon' of a similar negative charge. The half-life of these particles should be increased with decreasing the mass i.e. \( \tau^- < \mu^- < e^- \) (\( 2.9 \times 10^{-13} < 2.2 \times 10^{-6} \) <stable) due to (c/m) factor while the half-life for their antiparticles should be decreased in this direction \( \tau^+ > \mu^+ > e^+ \). The particle with lesser or greater ratio of (c/m), in reference to proton and electron, it will be unstable; it will have the lesser curvature in the magnetic field, i.e. tau' (tauon) and muon' have lesser curvature than proton and electron. The first and the second criteria and c/m ratio forbid all quarks to exist as stable elementary particles as these particles hold a fraction of charges. This c/m ratio is a general rule for estimation of the half-life of any particle and its antiparticle in reference to electron and proton.

\[ \text{Definition of } QM_n: \text{ The } _4^{12}He \text{ nuclide has atomic mass } M_A = 4.00260325413 \text{ u and it has 2 protons and 2 neutrons. The net weight of neutrons mass inside this nuclide is calculated like this (4.00260325413 - 2 M_p) or (4.00260325413 - 2x1.00782503207) = 1.98695318999 u. The } QM_n \text{ is equal to 1.98695318999/2 or equal to 0.993476594995 u.} \]
If we consider the mass quantization and \( c/m \) ratio and we plot the half-life of muon and tau versus their masses \( M \) (in MeV/c\(^2\)), we will get the straight line: \( \ln(t_{1/2}) = -0.0095M \) (MeV/c\(^2\)) - 12.027. From this simple approximate equation we can estimate the \( t_{1/2} \) of Kaon, \( K^- \) (493.677 MeV/c\(^2\)), to be \( 5.49450908 \times 10^{-8} \) s as compared with literature value of \( (1.238 \pm 0.0021 \times 10^{-8}) \) s; the \( t_{1/2} \) of Sigma, \( \Sigma^- \) (1,197.5 MeV/c\(^2\)), to be \( 6.8564 \times 10^{-11} \) s as compared with literature value of \( (1.479 \pm 0.011 \times 10^{-10}) \) s; the \( t_{1/2} \) of D-meson, \( D^- \) (1,869.60 MeV/c\(^2\)), to be \( 1.15650926 \times 10^{-13} \) s as compared with literature value of \( (1.04 \pm 0.007 \times 10^{-12}) \) s; and the \( t_{1/2} \) of Strange-D-meson, \( D_s^- \) (1,968.47 MeV/c\(^2\)), to be \( 4.52096878 \times 10^{-14} \) s as compared with literature value of \( (5.0 \pm 0.07 \times 10^{-13}) \) s\(^{[73]}\). The accuracy of the results depends on the accuracy of the input data. If there are three accurate points the results will be better.

The third criterion states that the \( m^+/m^- \) ratio, \( R_{mm} \), is one of the essential concepts in the particle structure. The charged particle ought to have \( R_{mm} = 1 \). The neutral particle ought to have \( R_{mm} > 1 \). This ratio will be increased in the neutron texture which will increase the mass of the neutrons in the nuclides of the heavier elements to attenuate the high positive columbic field of protons. The antiparticle ought to have \( R_{mm} < 1 \). This criterion clearly explains the type of decay. That means the neutron emits antimagnetons \( m^1 \) during the decay process while the proton emits magneton \( m^{-1} \) during the decay process. Most packages of the fermion’s texture work in special manner to neutralize the charge of each other to keep the charge of the fermion at stability state.

The fourth criterion states that the two magnetons \( m^{-1} \) and \( m^+1 \) create high gravity circular closed quantized packages of rings of magnetic dipoles in the form of matrices and that matrices have to keep the spin and the parity of the nucleon. These magneton matrices will have a different distribution of momentum among their magnetons but with a net proper spin value of \( \frac{1}{2} \).

The stable particle which achieves the fourth criteria is named a quantized mass particle. That means the stable charged particle should have a certain number of packages which complete the spin and the charge, positive or negative, and that ratio of \( m^+1/m^-1 \) has to equal to one as in electron and proton. The stable neutral particle should also have a certain number of packages that achieve the spin and a net charge equal to zero and that the ratio of \( m^+1/m^-1 \) has to be larger than one. The antiparticle is always unstable because it cannot achieve the \( c/m \). All types of antiparticles have unquantized mass. These criteria declare that the \( \beta^- \)-decay will be accompanied by antimagnetons (or \( \bar{\nu}_e \)) while \( \beta^+ \)-decay will be accompanied by magnetons (or \( \nu_e \)) based on the third criterion.

NMT theory has faith that there are three stable quantized mass fermions in the universe. These are the free and the bound electron, the free and the bound proton in stable nuclei and the bound neutron in the stable nuclide. The neutron has several quantized masses in the stable nuclides and its stability depends on its abundance in that nuclide. There is a high possibility to produce a stable neutral particle artificially through a special type of nuclear reactions and special facility in the future.

2.6. Electron-Positron

The building map or the texture of magnetons in electron and the positron textures is different. The electron has a quantized mass \( QM_e \) distributed over three nmtionic shells \( 1^{st} K, 2^{nd} L, \) and \( 3^{rd} M \) of negative charge which make it stable while the positron has unquantized mass \( UQM_e \) distributed over three nmtionic shells of positive charge which make it unstable as explained in the above items. The positron mass does not have enough packages of magneton matrices to hold the positive charge and it will disintegrate into discrete magnetons (or \( \nu_e \)). All electronic spectra come from the transition of these magneton packages inside the electron texture and interpreted by quantum atomic and molecular levels.

This new picture for the electron\(^{[27]}\), which is built from huge numbers of magnetons (\( m^+1 \) and \( m^{-1} \)), provides the real explanation as to why it behaves like waves and why it has mass. If we say that the mass of magneton is of 0.25 eV, that means the electrons consist of more than 2 million magnetons. This means the electron does not have a rigid ball mass but rather it is formed from packages of quantized mass \( QM_e \) that make it behaves like a beehive with a cloud of electric charge and a charged

\(^{[27]}\) Einstein’s last question at Stanford, in 1950, was: "I would just like to know what an electron is?" as Einstein saw the electron as the leading player in the universe. Now, in 2013, NMT provides the answer to Einstein’s question.
electromagnetic field. This innovative concept will conciliate and resolve the debate between the two schools of the Copenhagen (Niels Bohr, Werner Heisenberg, Max Born and others)\cite{74-76}, which adopts the hard sphere electron that deals only with probabilities of observing, or measuring, various aspects of energy quanta) and the Berlin school (Planck, Einstein, De Broglie which adopts the wave-form electron).

As we explained in the previous section, the two spinning-rotating magnetons create a Strong Charged Electromagnetic Force (SCEF) field of long range due to their own extraordinary strong magnetic constant ($\mu_b = 23\mu_o$) inside the electron nmtionic shells texture which makes it competent to bind itself with the OCEM shell of the nucleus of the atom. This magneton texture property grants the electron its specific character beyond OCEM shell attraction when it is free. The OCEM shell’s attraction (nucleus attraction force) role is only to bind the electrons to stay in quantized atomic orbital levels to build the atom.

The measured diffraction pattern of the electron by Clinton Davisson and Lester Germer\cite{77} in 1927 at Bell Labs, has to be attributed to the charged electromagnetic field of the electron and not to its mass body. This mass quantized model of the electron QM, gives clear explanations for all phenomena of the electron behavior as wave and as particle, such as the Ramsauer-Townsend effect\cite{78,79} which involves the scattering of low-energy electrons by atoms of a noble gas. In the photoelectric effect, the EM field of the light interferes with the charged EM field of the magnetons of the electron and excites and ionizes it as we explained in item 2.3.

2.6.1 Electron-Positron Disintegration

When the electron collides with the positron through the 3\textsuperscript{rd} M shells, they will form para/ortho-positronium atom of unquantized mass which means it does not achieve the four criteria. The magneton’s texture of this positronium atom will disintegrate into massive single magnetons (neutrinos) and the magnetons energy will be released and recorded as 1.022 MeV/c\(^2\) based on E=mc\(^2\) (or 0.21304612 MeV/bc based on E=mbc).

$$e^+ + e^- \rightarrow \text{Positronium atom} + \gamma\text{-ray} \ (2 \times 0.511 \text{ MeV/c}^2)$$

(22)

The released 1.022 MeV/c\(^2\) energy is due to the magnetons spinning and rotation motion.

After 0.124\textit{ns} \(\approx\) para

Positronium atom (Exotic Atom) \(\frac{142 \text{ns} - \text{othro}}{\text{will disintegrate}} \rightarrow \sum m^{-1} \ (or \nu_e) \ \sum m^{+1} \ (or \nu_e) + 28\)

This exotic atom texture will disintegrate into massive magnetons and antimagnetons based on NMT concepts because matter is quantized although SMT believes that this exotic atom will annihilate into two massless photons\cite{80}. There is a big difference between the two processes: the disintegration (due to mass quantization principle of NMT) and the annihilation (due to concepts of quantum field theory QFT). An excellent proof from literature assisting and confirming NMT’s mass quantization principle is that scientists found when the proton impacts its antiproton they will decay into mesons (mostly pions and kaons) and finally disintegrated into discrete magnetons. This NMT theory can be verified simply through setting an advanced system to measure the released magnetons after interaction of positron and electron or matter and its antimatter.

2.7. Muon and Tau

NMT theory describes the muon $\mu$ and its antiparticles (105.658 MeV/c\(^2\) or 207\textit{m}$_e$)\cite{81} as packages of magnetons with unquantized mass usually produced during the failure of the rearrangement of the magnetons of the negative packages of the nmtionic shells 1\textsuperscript{st} K and 4\textsuperscript{th} N inside the neutron in the stars to equalize magnetons of the positive packages of 2\textsuperscript{nd} L and 3\textsuperscript{rd} M to reach the final zero charge. The tau $\tau$ and its antiparticles (1777 MeV/c\(^2\) or 3477Me\(_c\) or ca. 2Me\(_n\)) usually happen when two neutrons in the stars merged (to have ca. 1878 MeV/c\(^2\)) to rearrange themselves to reach the stabilized quantized mass. These four particles $\mu^-, \mu^+, \tau^-$ and $\tau^+$ are unstable due to improper ($c/m$) ratio and they cannot be

\textsuperscript{28} We kept the symbol of the neutrino $\nu_e$ with the magneton in all equations to remember the reader that the neutrino and antiparticle are single magnetons and its antiparticle.
accelerated in a magnetic field due to the lack of quantized mass to complete the unitary elementary charges and, in addition, to their short half-lives. They are produced during certain particle accelerator experiments with hadrons in addition to their existence in the natural cosmic rays. NMT predicts that these two particles may be created and emitted from very heavy nuclei with \(Z>110\) during natural fission reactions due to their high nuclear energy that makes the conservons \(\kappa\) incapable to keep the proton and the neutron textures in quantized mass.

The ratio of charge over mass \((c/m)\) in muon is very small compared with that of electron which enables muon to penetrate to the Earth’s surface, and even into deep zones. This means that muon will face less bremsstrahlung mechanism during penetration. Muon and its antiparticle will decay into electron and positron with extra packages of magnetons which later will be disintegrated into discrete magneton and antimagneton, rather than just one or the other. The positron will undergo further disintegration into discrete magnetons (or \(\nu_e\))

\[
\mu^{-} = e^{-} + m^{+1} (or \bar{v}_e) \quad \text{and} \quad \mu^{+} = e^{+} + m^{-1} (or v_e) \quad (23)
\]

Tau and its antiparticle \((1777 \text{ MeV}/c^2)^{[73,82]}\) will decay into electron and positron with extra packages of magnetons which later will be disintegrated into magneton and antimagneton. During the disintegration, NMT predicts, there is a high possibility for producing negative and positive neutrons of short half-life less than \(10^{-10}\) s which are disintegrated to muons and finally disintegrated into single magneton and antimagneton.

SMT believes that these two particles, muon and tau, are elementary fermions but as they do not have quantized masses, NMT consider them as unstable non-elementary particles. They are just intermediary unstable particles in nuclear genesis in the stars or one species of collision products in the colliders.

### 2.8. Proton and Neutron

The NMT theory proposes that the proton is stable inside the stable nucleus and outside the nucleus with three quantized shells 1\(^{st}\) K, 2\(^{nd}\) L and 3\(^{rd}\) M because it has certain quantized mass \(Q_{M_p}\), while the neutron has several quantized masses \(Q_{M_n}\) depending on the stable isotopes of the elements. This high stability of proton makes it the most abundant nuclear particle in the universe and the best fusion fuel for the stars.

In \(\beta^+\)-decay process, when the proton suffers from high positive colomic field due to the lack of neutron numbers, the proton tends to convert to neutron. Either it will convert itself to neutron directly to emit \(\beta^+\), as it has enough mass\(^{29}\), to rearrange its nmtionic shells to create the 4\(^{th}\) N shell to converse the charges of the shells with help from the conservons \(\kappa\) to convert to neutron. In this process, it will grant some of the extra packages of magnetons to the other neutrons and the remainder will be released as magnetons. Or through capturing an electron, EC, from inner atomic orbital, it will change its texture to create the 4\(^{th}\) N shell by help of the conservons \(\kappa\) to convert itself into neutron and to emit the extra magnetons as discrete magnetons (neutrinos).

\[
p^+ + \text{conservon}_d \quad \text{Four – Forcecarrier} \quad n^0 + e^+ + m^{-1} (or \bar{v}_e). \quad (24) \quad (\text{When} \quad E_{f,mother}^o < E_{f,daughter}^o \quad \text{or} \quad E_{f,mother}^o > E_{f,daughter}^o) \quad (25) \quad \text{see item-4.7}
\]

In \(\beta^+\)-decay process, one positron \(\beta^+\) will be emitted which is equal to the mass of the electron, but its three nmtionic shells have a positive charge with a very short half-life. This positron will either disintegrate into packages of magnetons or collides with an electron which finally disintegrates to discrete magnetons releasing energy. The released energy from the conversion process of the proton to neutron will depend on the difference between quantized neutron mass \(Q_{M_n}\) in the stable daughter and

\(^{29}\) The mass of the proton \(M_p^*\) is fixed anywhere \((M_p^* = 1.007276466812 \text{ u})\) while the neutron masses in the nuclei have a wide spectrum covers the range from 0.990304 u in \(^{40}\text{Ca}\) (the least mass for neutron) to 1.0094941617 u in \(^{5}\text{Be}\) (the greater mass for the neutron).
the unquantized neutron mass $UQM_n$ in the radioactive mother as $QM_p$ is always constant. The radioactive isotope that has $UQM_n$ less than the $QM_n$ of the stable isotope will affect the proton stability as it undergoes the $\beta^+/EC$ decay process. The EC-decay become competitive with $\beta^+$-decay only when the neutron mass of that isotope has a shortage in neutron numbers by one or two neutrons to reach the quantized mass of the stable isotope (or when $UQM_n$ value is very close to $QM_n$ value) (see also item-4.7). When there is a high shortage in neutron mass then the $\beta^+$-decay process is the dominant phenomenon (or when $UQM_n$ value is far from $QM_n$ value).

During $\beta^-$-decay, the neutron that acquires extra packages of magnetons from the total mass of the neutrons during nucleosynthesis will be ready to convert to proton and electron. In this process, the $1^{st}$ K core shell changes its charge from negative to positive with help from the conservons $\kappa$; and the outer $4^{th}$ N shell will acquire the unitary elementary negative to be released as beta ray; and the $1^{st}$ K shell will change its negative charge to positive charge to convert to proton. The released energy from the conversion process of the neutron to the proton will depend on the difference between quantized neutron mass $QM_n$ in the daughter and the unquantized neutron mass $UQM_n$ in the radioactive mother.

$$n^0 \xrightarrow{\text{Four-Forcecarrier}} p^+ + e^- + m^+ (or \nu_e) \quad (26)$$

In the isobars series, the daughter still has $UQM_n$ and will undergo further decay to reach the $QM_n$. NMT believes that there is a possibility for the antiproton formation as an intermediate stage particle in $\beta^+$-decay and EC process while the antineutron formation as an intermediate stage particle in $\beta^-$-decay process.

**Second: Application and Results of NMT- Mass Quantization**

In this part, we will apply the **Mass Quantization Principle QMP** of the NMT to neutron mass to calculate the Q-value of all types of nuclear reactions using several sources and reference[83-89] in addition to the Brookhaven National Laboratory BNL, OECD, IAEA. JAEA data of 2011 are the most recent among the other sources. We found some minor differences in the mass of nuclides, half-lives, and decay energies among these sources which affect slightly the results. There are also different values for half-lives and energies of decays in these sources so we took care of that.

**3. Neutron Mass Quantization Principle Application for Isobars and Isotope**

Contrary to proton, the neutron has several quantized masses as we mentioned in item 2.5. For example, the $\frac{7}{3} Li$, which has a neutron quantized $QM_n=0.998132363$ u (calculated from the formula $(M_A-ZM_H)/N)$ is stable; while the $\frac{8}{3} Li$, with neutron unquantized mass $UQM_n=0.9998024532$ u, is unstable (with difference of +0.0016700902 u) and it has half-life 0.84s; and the $\frac{12}{3} Li$, with neutron unquantized mass $UQM_n=1.003367211556$ u, is unstable (with difference of +0.00523484856 u) and it has half-life 11.4 ms. One more example can be depicted regarding the oxygen isotopes. The following oxygen isotopes [$^{13}O, ^{14}O, ^{15}O$ has $UQM_n$ and are unstable), ($^{16}O, ^{17}O, ^{18}O$ has $QM_n$ and are stable), ($^{19}O, ^{20}O, ^{21}O, ^{22}O, ^{23}O, ^{24}O, ^{25}O, ^{26}O$ has $QM_n$ and are unstable)] have the following half-life respectively [8.58ms, 70.64s, 2.041m, ($^{16}O, ^{17}O, ^{18}O$ are stable), 26.88s, 13.51s, 3.42s, 2.25s, 90ms, 65ms, 5ns and 4ns]. It is very clear that the closer isotope to the neutron quantized mass $QM_n$ has a longer the half-life and that the isotope with higher $UQM_n$ has a shorter half-life.

The special characteristic property of the neutron is that it can have several quantized masses inside the nuclides which are responsible for the existence of isotopes, their decay, and all

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30 See footnote xxv page-19. We may denote $M^*_n$ to $QM_n$ in stable nuclide and $UQM_n$ in unstable nuclide to differentiate it from the free neutron mass $M_n$. 
type of nuclear reactions. The half-life rule of the radioactive isotope states that the closer the neutron is to the quantized mass $Q_{M_n}$, the longer the half-life. This is a general rule for all isotopes’ half-life.

The neutron quantized mass $Q_{M_n}$ is increased in heavier elements to attenuate the extraordinary positive columbic field of the big number of protons. For example the neutron quantized masses $Q_{M_n}$ (u) in the following nuclides are 0.99030 in $^{40}\text{Ca}$ (96.94%), 0.9913 in $^{59}\text{Co}$ (100%), 0.9935 in $^{138}\text{Ba}$ (71.7%), 0.994628 in $^{202}\text{Hg}$ (29.8%), 0.995417 in $^{238}\text{U}$ (99.275%) and it is still increasing to become $UQ_{M_n}$ in 0.995525 in $^{244}\text{Pu}$ (artificial) and 0.995992 in Ununpentium-291(artificial). We may notice also that the $Q_{M_n}$ is always greater in the nuclide of odd proton numbers than in even proton numbers.

As we discussed in the previous sections 2.5, we denote the neutron mass in the stable isotope as quantized neutron mass $Q_{M_n}$, and we denote the neutron mass in the radioactive isotope as unquantized neutron mass $UQ_{M_n}$. When the number of packages of magnetons of the neutron is increased $+\Delta(UQ_{M_n}-Q_{M_n})$ or $+\Delta UQ_{M_n}$ or decreased $-\Delta(UQ_{M_n}-Q_{M_n})$ or $-\Delta UQ_{M_n}$ in the neutron in the isotope relative to $Q_{M_n}$ values, it will become unstable and it will decay.

![Figure-2: The relation between the $Q_{M_n}$ and $UQ_{M_n}$ and the decay mode](image)

If we imagine that the quantized mass $Q_{M_n}$ of the stable isotope of any element located in the middle of the neutron mass stability curve (plateau), then the values of unquantized mass of neutron $UQ_{M_n}$ in the isotopes series will be distributed on the both sides of the plateau (above $+\Delta$ and down $-\Delta$).

The radioisotope which is closer (small $|\Delta|$) to the plateau will have a longer half-life with lower energy ($\beta^+$ or $\alpha$) while the farther radioisotope (large $|\Delta|$) from the plateau will have a shorter half-life with higher energy as shown in Figure-2 based on the Mass Quantization Principle QMP.

The highest $UQ_{M_n}$ mass is in $^5\text{Be}$ (1.0094941617 u), free neutron (1.0086649157 u), and $^7\text{H}$ (1.0074876747 u), the other values will be below these values. The highest $Q_{M_n}$ mass is in deuterium (1.0062767459 u) and in $^3\text{He}$ (1.000379246 u) while the lowest $Q_{M_n}$ is in $^{40}\text{Ca}$ (0.990304 u). The $Q_{M_n}$ values fall in the range 0.9910-0.9925 u gives the highest binding energy in nuclei with $Z>20$. See Diagram-5 in Appendix-A.

NMT applied the Mass Quantization Principle QMP to the neutron mass in nuclear calculations. The $UQ_{M_n}$ refers to any amount of mass acquired or lost relative to the neutron quantized mass $Q_{M_n}$ of the nearest stable isotope. This differential amount is expressed by $\Delta UQ_{M_n}$.

$\Delta UQ_{M_n}$ is defined as the difference in mass of neutron when it is in the unstable isotope $UQ_{M_n}$ and in the stable isotope $Q_{M_n}$. For example the $Q_{M_n}$ in $^{40}\text{Ca}$ is 0.990304511 u and the $UQ_{M_n}$ in $^{40}\text{Ca}$ is 0.99075129755238 u and $\Delta UQ_{M_n}$= 0.00044678647238 u.
These sequential differences in the mass of neutron, \( \Delta \text{UQM}_n \), in the isotopes give a good estimation for half-life \( t_{1/2} \) of these isotopes as we will see in later sections.

### 3.1. Isobar Energy Formula

The energy difference between two isobars \( _{z+1}A \) and \( _zB \) can be calculated from the difference in neutron mass \( \Delta \text{UQM}_n \) between the two isobars. The general formula is:

\[
\Delta E_{\text{isobars}} = [(M_A - (Z-1)M_H)_A - (M_A-ZM_H)_B] \times 931.5 \text{ MeV/c}^2
\]

The \( \Delta E_{\text{isobars}} \) between 11\(^6\)C and 11\(^5\)B is 1.9824 MeV/c\(^2\) (or 0.41334 MeV/bohr) which is in good agreement with experimental value 1.98 MeV/c\(^2\) and literature values 1.95 MeV/c\(^2\). Table-1 shows more examples.

**Table-1:** Isobar energy (MeV/c\(^2\)) calculated by Isobar Energy Formula Eq. 27

<table>
<thead>
<tr>
<th>Isobars</th>
<th>Theoretical(^{44})</th>
<th>Experimental</th>
<th>( \Delta E_{\text{isobar}} \text{ Eq.27} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{12})N  (^{12})C</td>
<td>2.28</td>
<td>2.26</td>
<td>2.2204</td>
</tr>
<tr>
<td>(^{16})O  (^{16})N</td>
<td>2.62</td>
<td>2.70</td>
<td>2.7542</td>
</tr>
<tr>
<td>(^{12})K  (^{12})O</td>
<td>2.95</td>
<td>3.02</td>
<td>2.7605</td>
</tr>
<tr>
<td>(^{22})Ne  (^{22})F</td>
<td>3.27</td>
<td>3.22</td>
<td>3.2388</td>
</tr>
</tbody>
</table>

\(^{44}\)Ref-64 page 373 eq. (10-8), \( \Delta E_{\text{isobar}} = 1.2 \frac{(Z-1)}{A^{1/3}} - 0.7847 \) (MeV/c\(^2\))

### 3.2. \( \beta^- \), \( \beta^+ / \text{EC} \) and \( \alpha \)-Decay Rules

When unquantized neutron mass \( \text{UQM}_n \) in the isotope becomes greater than (i.e. +\( \Delta \)) the quantized mass \( \text{QM}_n \) of the stable isotope, it will undergo \( \beta^- \)-decay i.e. \( (M_A-ZM_H)_{\text{mother}} > (M_A-ZM_H)_{\text{daughter}} \). In the \( \beta^- \)-decay, the neutron will decay into proton and electron with help from the conservons \( \kappa \) and will release the remainder antimagnetons as certain types of packages into the environment as huge antimagnetons with different gamma energies which result in a continuous spectrum. When the unquantized neutron mass \( \text{UQM}_n \) in the isotope becomes lesser (i.e. -\( \Delta \)) than the quantized mass \( \text{QM}_n \) of the stable isotope it will undergo p/\( \beta^+ / \text{EC} \)-decay and \( \alpha \)-decay, i.e. \( (M_A-ZM_H)_{\text{isotope}} < (M_A-ZM_H)_{\text{stable isotope}} \). In the \( \beta^- \)-decay, the proton will decay into neutron and positron with help from the conservons \( \kappa \) and will release the remainder antimagnetons as certain types of packages into the environment with different gamma energies.

The Mass Quantization Principle QMP rule states that no radioactive isotope in the middle of beta-emitter series of one element has a longer half-life than the preceding isotope due to \( \Delta \text{UQM}_n \). This is a general rule for all elements isotopes half-lives. Few synthesized isotopes show exceptions. The decay process is mass quantized and not random process where the neutron with \( \text{UQM}_n \) decays until it reaches the plateau of the \( \text{QM}_n \).

Most isotopes belong to the elements beyond \(^{22}\)Ti, next to the stable isotope of \( \text{QM}_n \) (see the plateau in Fig-2), show strange phenomenon that they have short half-lives which break QMP. NMT theory may explain this strange phenomenon based on the mass quantization principle. The born isotope via positron decay, for example \(^{40}\)Cr, has \( \text{UQM}_n \) (0.9905413 u) which requires one neutron to reach the \( \text{QM}_n \) (0.990702 u) in the stable isotope, \(^{50}\)Cr, in the plateau. This means the neutron quantized mass \( \text{QM}_n \) in the isotope \(^{40}\)Cr) resist to lose one neutron to convert to \( \text{UQM}_n \) in the \(^{40}\)Cr that made this isotope highly unstable with very short half-life (42.3m) in comparison with half-life of \(^{48}\)Cr (21.56hr) which has smaller \( \text{UQM}_n \) (0.99026 u).

The isotopes, which are next by one or two to \( \text{QM}_n \) in the left side of Fig-2, tend to decay with EC-decay but the farther isotope will decay by \( \beta^+ \)-decay. The EC-decay takes place only when the born daughter is stable and \( \Delta \text{UQM}_n \leq 3 \text{MeV} \). The isotopes which are next to \( \text{QM}_n \) in the right side have a
shorter half-life and they tend to undergo β−-decay. For elements with Z>67, alpha decay will compete β−/EC-decay. Some times when these β-emitters isotopes emit alpha there will be a small break down in the consequence of these half-life due to the total change in the neutron masses. The heavy radioactive elements usually break this rule due to the alpha decay and fission process. IT mode is almost always found associated with these decay modes.

All these rules of decay are broken in the heavy element above plutonium where you find the heavy nuclide decays by β−-decay (98%) plus α-decay (2%).

3.3. Prediction of Isobars Energies from Mass Quantization Principle

The beta emitters in the isobar series try to decrease the UQMₙ through β−-decay process to reach the QMₙ in the end of this isobar series. The isobar half-life should become longer and the energy of the beta decay becomes less in the end of this isobar series due to decease in the UQM. The β−-energy (keV) of the two isobars series ⁹³Br and ¹³⁷Te, as an example, have been plotted versus the mass increment Δm in ΔUQMₙ which gave a straight line to confirm the mass quantization principle MQP as shown in Fig-3&4 (see Appendix-A for Δm calculation). The Δm in ΔUQMₙ explains how much extra mass was acquired by the neutrons in the consecutive unstable isobars relative to mass of the neutron in the stable isobar which stands in the end of the isobar series. The isobars series of A=93 which starts with ⁹³Br and ends with stable ⁹³Nb showed that the experimental value of the decay energy of the ⁹³Br is inconsistent with its peer isobars. The linear correlation between the β−-energy and the Δm in ΔUQMₙ for these isobars has been plotted as seen in Figure-3 which predicted the β−-energy of ⁹³Br to be 9138.762 keV rather than 11283 keV which is mentioned in the literature. The beta energy of ⁹¹Br isobar series can be described by the following equation:

\[ E_\beta = 946004 \Delta m - 61.608 \ldots \ldots R^2 = 0.9998 \ldots \ldots \text{for} \ ³⁵\text{Br Isobars} \] (28) (see Fig-3)

\[ \frac{³⁵\text{Br}}{11283 \text{keV} \ldots \ldots ³⁵\text{Kr}} \frac{1.286 \text{s}}{8500 \text{keV} \ldots \ldots ³⁷\text{Rb}} \frac{5.84 \text{s}}{7461 \text{keV} \ldots \ldots ³⁹\text{Sr}} \frac{7.423 \text{m}}{3547 \text{keV} \ldots \ldots ³⁹\text{Y}} \frac{10.18 \text{h}}{708 \text{keV} \ldots \ldots ⁴⁰\text{Zr}} \frac{1.53 \times 10^6 \text{Y}}{⁹¹\text{Nb}} \]

another example, plotting β−-decay energy of ¹³⁷Te versus Δm in ΔUQMₙ shows a similar behavior to confirm the mass quantization principle MQP as seen in Figure-4. The linear correlation between the β−-energy and the Δm in ΔUQMₙ for these isobars predicts the β−-energy of ¹³⁷Te to be 3122.529 keV (no certificated experimental value from BNL). The beta energy of ¹³⁷Te isobar series can be described by the following equation:

\[ E_\beta = 3 \times 10^7 \Delta m - 4148.8 \ldots \ldots R^2 = 0.9943 \ldots \ldots \text{for} \ ³⁵\text{Te Isobars} \] (29) (see Fig-4)

\[ \frac{¹³⁷\text{Te}}{3122.53 \text{keV} \ldots \ldots ¹³⁷\text{I}} \frac{2.45 s} {1854 \text{keV} \ldots \ldots ¹³⁷\text{Xe}} \frac{3.818 m} {1323 \text{keV} \ldots \ldots ¹³⁷\text{Cs}} \frac{30.8 y} {513.97 \text{keV} \ldots \ldots ¹³⁷\text{Ba}} \]

The energies of the ¹³⁷Te isobar series from IAEA are different from BNL. Other examples: the isobars series ¹³⁹I and ¹⁵⁷Pm show similar correlations between β−-energy and Δm in ΔUQMₙ (see Appendix-A for Tables-2&3 and Figures-5&6). The beta energy of ¹³⁹I isobar series can be described by the following equation:

\[ \Delta m \text{ definition: } \Delta m = \Delta UQM_{n-} - \Delta UQM_{n} \text{. For example: the neutron unquantized mass UQM}_{n} \text{ in the } ¹³⁹\text{I is } 0.9943182881627 \text{ u and the neutron unquantized mass UQM}_{n} \text{ in the } ¹³⁹\text{Xe is } 0.9940734259764 \text{ u. The consecutive } \Delta UQM_{n} \text{ of } ¹³⁹\text{I is } 0.0008996730042 \text{ and the consecutive } \Delta UQM_{n} \text{ of the } ¹³⁹\text{Xe is } 0.0006548108179 \text{ relative to the stable } ²²⁹\text{La} \text{. The } \Delta m = \Delta UQM_{n-} - \Delta UQM_{n} \text{.} \ ¹³⁹\text{I(Xe-139)} = 0.002448621863. \text{ See Table-2&3 in Appendix-A.} \]

\[ E_\beta = 3 \times 10^7 \Delta m - 16080, R^2 = 0.9962 \text{ for IAEA } E_\beta \text{-values} (7216.72, 5876.53, 4162.55, 1175.63 \text{ for Te, I, Xe and Cs respectively).} \]

---

\[ \Delta m \text{ definition: } \Delta m = \Delta UQM_{n-} - \Delta UQM_{n} \text{. For example: the neutron unquantized mass UQM}_{n} \text{ in the } ¹³⁹\text{I is } 0.9943182881627 \text{ u and the neutron unquantized mass UQM}_{n} \text{ in the } ¹³⁹\text{Xe is } 0.9940734259764 \text{ u. The consecutive } \Delta UQM_{n} \text{ of } ¹³⁹\text{I is } 0.0008996730042 \text{ and the consecutive } \Delta UQM_{n} \text{ of the } ¹³⁹\text{Xe is } 0.0006548108179 \text{ relative to the stable } ²²⁹\text{La} \text{. The } \Delta m = \Delta UQM_{n-} - \Delta UQM_{n} \text{.} \ ¹³⁹\text{I(Xe-139)} = 0.002448621863. \text{ See Table-2&3 in Appendix-A.} \]

\[ E_\beta = 3 \times 10^7 \Delta m - 16080, R^2 = 0.9962 \text{ for IAEA } E_\beta \text{-values} (7216.72, 5876.53, 4162.55, 1175.63 \text{ for Te, I, Xe and Cs respectively).} \]
E_β = 1 \times 10^8 \Delta m - 19990 \ldots R^2 = 0.9962 \ldots \text{for } _{63}^{139} \text{I Isobars} \quad (30) \text{ (see Fig-5)}

\[
\begin{align*}
_{53}^{139} \text{I} & \quad 2.285s \\
_{84}^{54} \text{Xe} & \quad 39.68s \\
_{55}^{139} \text{Cs} & \quad 9.27m \\
_{56}^{139} \text{Ba} & \quad 85.06m \\
_{57}^{139} \text{La} & \quad 2317 keV
\end{align*}
\]

And the beta energy of \(^{157}\text{Pm}\) isobar series can be described by the following equation:

E_β = 1 \times 10^8 (\Delta m) - 15888 \ldots R^2 = 1.00 \ldots \text{for } _{66}^{157} \text{Pm Isobars} \quad (31) \text{ (see Fig-6)}

\[
\begin{align*}
_{61}^{157} \text{Pm} & \quad 10.65s \\
_{62}^{157} \text{Sm} & \quad 482s \\
_{63}^{157} \text{Eu} & \quad 15.18h \\
_{64}^{157} \text{Gd} & \quad 1299 keV
\end{align*}
\]

The linear correlation between the \(\beta^-\)-energy and the \(\Delta m\) in \(\Delta\text{UQM}_n\) of any isobar series helps in prediction of the proper \(\beta^-\)-energy of a very short half-life isobar. The slope (in keV/u) in each formula might be used to estimate the \(\beta^-\)-energy of any isobars in the series. The same formula can be calculated for the isotopes using \(\Delta\text{UQM}_n\) instead of \(\Delta m\) in \(\Delta\text{UQ}\) to estimate \(\beta^-\)-energy of any isotope of that element. For example we plot \(\beta^-\)-energy versus \(\Delta\text{UQM}_n\) for Ga-isotopes which gave \(E_\beta = 5 \times 10^6 \Delta\text{UQM}_n + 762.59, R^2 = 0.997\). From the slope \(5 \times 10^6\) (keV/u) we estimated \(E_\beta\) for more than ten isotopes \(^{72}\text{Ga}\)\(^\longrightarrow\)\(^{83}\text{Ga}\) (3148.828, 3924.971, 5009.652, 5793.143, 6849.912, 7643.266, 8629.230, 9447.957, 10470.513, 11266.627, 12357.953, 13301.640 KeV/c\(^2\)), for example, the estimated \(E_\beta\) for \(^{80}\text{Ga}\) was 10470 keV compared with the measured value 10380 keV from NBL. These types of formula can be used also to any element’s isotope. The mass quantization principle MQP also helps in evaluation of the half-lives of the very short half-life isobars and isotopes, as we will see in forthcoming paragraphs. The high precision input data and the best formula will give the most accurate values. This is general rule for all the correlations formulas used in this article.

**Figure-3:** \(\beta^-\)-decay energies (keV) versus \(\Delta m\) in \(\Delta\text{UQM}_n\) for \(^{93}\text{Br}\) Isobars

**Figure-4:** \(\beta^-\)-decay energies versus \(\Delta m\) in \(\Delta\text{UQM}_n\) for \(^{137}\text{Te}\) Isobars

### 3.4. Half-life Prediction of Isobars from Mass Quantization Principle

Since the 1940s, the study of fission products of more than 400 radionuclides produced in the nuclear reactors has required extensive and advanced work in radiochemistry for separation and measurement of very short half-life isotopes. The fission fragments always have neutrons with \(\text{UQM}_n\). These isobaric mass chains emit a few neutrons first and then start to emit beta rays to reach the nuclide with \(\text{QM}_n\). The half-lives of the first isobars \(^{93}\text{Br}\) or \(^{137}\text{Te}\) are usually very short which is difficult to be measured accurately. The mass quantization principle MQP of this NMT supposed that the half-lives of these isobars are highly dependent on the amount of the \(\text{UQM}_n\). The half-life is affected mainly by two factors. The major factor is the \(\text{UQM}_n\) and the minor factor is the binding energy \(E_b\). The half-life of these isobars is directly proportional to the binding energy and inversely to \(\text{UQM}_n\). Plotting the half-lives of these isobars versus \(1/\Delta m\) in \(\Delta\text{UQM}_n\) will give a straight line that helps in estimation of short
half-life of the first isobars. Insertion of \( E_b \) with \( 1/\Delta m \) as \( (E_b/\Delta m) \) will slightly enhance the correlation coefficient \( R^2 \). These Figures 7-10 are only for \( \beta^- \)-decay.

The mass quantization principle MQP of the NMT states that sequential increments in neutron mass \( \Delta m \) (in \( \Delta UQM_n \)) in the series of the isobars will predict the half-life of the isobars.

For example, the isobars series of \( ^{93}\text{Br} \) showed that half-life and the energy of beta of \( ^{93}\text{Br} \) are not accurately measured. The half-life of \( ^{93}\text{Br} \) isobar series can be described by the following equation:

\[
\ln(t_{1/2}) = 5 \times 10^{-6} \left( \frac{E_b}{\Delta m} \right) - 4.334 \quad \text{...} R^2 = 0.9952 \quad \text{for } ^{93}\text{Br} \text{ Isobar} \quad (32) \quad (\text{see Fig-7})
\]

\[
^{93}\text{Br} \quad 102\text{ms} \quad ^{93}\text{Kr} \quad 1.286 \text{ s} \quad ^{93}\text{Rb} \quad 5.84 \text{ s} \quad ^{93}\text{Sr} \quad 7.423 \text{ m} \quad ^{93}\text{Y} \quad 10.18 \text{ h} \quad ^{93}\text{Zr} \quad 1.53 \times 10^6 \text{ Y} \quad ^{93}\text{Nb}.
\]

Plotting the half-lives of \( ^{93}\text{Br} \) series versus \( (E_b/\Delta m) \) in \( \Delta UQM_n \) gives a linear correlation that predicted \( t_{1/2} = 161.58 \text{ ms} \) rather than 102 ms for \( ^{93}\text{Br} \) as seen in Figure-7.

**Figure-7:** \( \ln(t_{1/2}) \) of \( ^{93}\text{Br} \) versus \( E_b/\Delta m \) in \( \Delta UQM_n \)

The two isobars series \( ^{139}\text{I} \) and \( ^{157}\text{Pm} \) show similar correlations as seen in Figures-9\&10, see Appendix-A. The half-life of \( ^{139}\text{I} \) isobar series can be described by the following equation:

\[
\ln(t_{1/2}) = 1 \times 10^{-6} \left( \frac{E_b}{\Delta m} \right) - 31.847 \quad \text{...} R^2 = 0.9983 \quad \text{for } ^{139}\text{I} \text{ Isobar} \quad (34) \quad (\text{see Fig-9})
\]

\[
^{139}\text{I} \quad 2.285 \text{s} \quad ^{134}\text{Xe} \quad 3.968 \text{s} \quad ^{139}\text{Cs} \quad 9.27 \text{h} \quad ^{139}\text{Ba} \quad 85.06 \text{m} \quad ^{139}\text{La}.
\]

The half-life of \( ^{157}\text{Pm} \) isobar series can be described by the following equation:

\[
\ln(t_{1/2}) = 4.052 \times 10^{-38} \left( \frac{E_b}{\Delta m} \right)^{4.9405} \quad \text{...} R^2 = 0.9934 \quad \text{for } ^{157}\text{Pm} \text{ Isobar} \quad (35) \quad (\text{see Fig-10})
\]

\[
^{157}\text{Pm} \quad 10.65 \text{s} \quad ^{152}\text{Sm} \quad 482 \text{s} \quad ^{157}\text{Eu} \quad 15.18 \text{h} \quad ^{157}\text{Gd}.
\]

In conclusion, we have estimated the half-life for \( ^{93}\text{Br} \), \( ^{137}\text{Te} \) and \( ^{139}\text{Cs} \) to be 161.58 ms, 6.576 s and 264 s rather than literature values 102 ms, 2.45 s and 556 s respectively. These estimated values have been used in calculation of the radioactivity in item 3.7 and they give better results. The mass quantization principle suggests the half-life of the \( ^{157}\text{Pm} \) has to be 50 s to get \( \ln(t_{1/2}) = 2 \times 10^{-7} \left( E_b/\Delta m \right) + 1.4843 \), \( R^2 = 0.9987 \).
3.5. Half-Life Prediction of Isotopes from Mass Quantization Principle

Although SMT tried to find out the factors that affect the decay rate or half-lives of radioactive isotopes such as energy change, spin change, and parity change to predict half-lives but it was not completely successful in discovering the true reason behind these half-lives. NMT theory tries to explain the half-lives of radioactive isotopes based on the mass quantization principle.

As we discussed, the neutron has several quantized masses $Q_M^n$ which are available in the stable isotopes of that element. When the isotope has an excess of neutrons, it will acquire unquantized neutron mass $+\Delta UQM^n$ which result in $\beta^-$-decay. When the isotope has insufficient neutron mass, it will acquire unquantized neutron mass $-\Delta UQM^n$ which will lead to $\beta^+/\text{EC}$-decay. This extra neutron mass affects the stability of the isotope. As we stated, the half-life is mainly affected by the binding energy per nucleon and the successive unquantized mass value $UQM^n$. Other factors such as spin and parity have minor effects. This means the $t_{1/2}$ is proportional to $(E_b/\Delta UQM^n)$ or $t_{1/2} = e^{f(E_b/\Delta UQM^n)}$, where $f$ is any proper mathematical function which can be determined from the experimental graph.

**Figure-13:** $\ln(t_{1/2})$ versus $E_b/\Delta UQM^n$ calculated from nine isotopes $^{75}\text{Ga}$-$^{81}\text{Ga}$

**Figure-14:** $\ln(t_{1/2})$ versus $E_b/\Delta UQM^n$ calculated from four isotopes $^{73}\text{Ga}$-$^{77}\text{Ga}$

In case of the isobars, we have to use $\Delta m$ in $\Delta UQM^n$ of the isobar series while in the case of the isotopes, we have to use $\Delta UQM^n$ only because the isotopes have different atomic mass number $A$ while the isobars have the same $A$.

The mass quantization principle MQP of this NMT states that $\Delta UQM^n$ in neutron mass in the series of the isotopes will predict the half-life of the isotopes.

Qualitative inverse correlations between the half-lives and $E_b/\Delta UQM^n$ are recognized for several isotopes. For example the gallium isotopes starting from $^{69}\text{Ga}$ till $^{83}\text{Ga}$ have been studied in detail. The $^{69}\text{Ga}$ is the most stable isotope which has a quantized mass neutron $Q_M^n$. When the masses of the neutrons in the other isotopes are deducted from this quantized mass (reference mass) and multiplied by $E_b$ and are plotted against their half-life, the graph gives a good correlation as seen in Figure-13.

Plotting $\ln(t_{1/2})$ for $^{73}\text{Ga}$, $^{75}\text{Ga}$, $^{76}\text{Ga}$, and $^{77}\text{Ga}$ versus $(E_b/\Delta UQM^n)$ gives the following correlation:

$$\ln \left( t_{1/2} \right) = 0.0013 \left( \frac{E_b}{UQM^n} \right) - 4.8049, \quad R^2 = 0.9995 \quad (36)$$

This correlation predicted the half-life of other heavier isotopes for gallium and compared with the experimental values as seen in Fig-13&14 and their data are Table-4&5, see Appendix-A.

These types of correlations will help in predicting the half-life of the created or synthesized isotopes in the nuclear reactors and accelerators. Figures-13&14 show the linearity of the half-life with the neutron mass increments which pass over the quantized mass of stable isotope and lead to

---

34 For example, the neutron quantized mass $Q_M^n$ in the stable isotope $^{69}\text{Ga}$ is 0.991683533921053 and the neutron unquantized mass $UQM^n$ in the unstable isotope $^{72}\text{Ga}$ is 0.992287567707317. The $\Delta UQM^n = UQM^n (^{72}\text{Ga}) - Q_M^n (^{69}\text{Ga}) = 0.00060403786264 \text{ u.}$
instability of the isotope; and it will decay with a shorter half-life. This graph is only for β−-emitters. β−-decay will follow the same procedure.

Plotting ln (t_{1/2}) for ^{20}\text{O}, ^{21}\text{O} and ^{22}\text{O} versus ln(E_b/\Delta UQM_n) gives the following correlation:

\[ \ln \left( \frac{t_{1/2}}{t_{1/2}} \right) = 6.1033 \ln \left( \frac{E_b}{\Delta UQM_n} \right) - 44.413, \quad R^2 = 0.9947 \]  

(37) (see Fig-15)

Table-6: Comparison of the predicted t_{1/2} values with experimental values

<table>
<thead>
<tr>
<th>Ga-Isotopes</th>
<th>Experimental t_{1/2} in sec</th>
<th>Predicated t_{1/2} in sec (Fig-14)</th>
<th>O-Isotopes</th>
<th>Experimental t_{1/2} in sec</th>
<th>Predicated t_{1/2} in sec (Fig-15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ga-77</td>
<td>13</td>
<td>14.09</td>
<td>O-22</td>
<td>2.25</td>
<td>2.13391</td>
</tr>
<tr>
<td>Ga-78</td>
<td>5.1</td>
<td>5.78</td>
<td>O-23</td>
<td>0.097</td>
<td>0.83473</td>
</tr>
<tr>
<td>Ga-79</td>
<td>3.0</td>
<td>3.19</td>
<td>O-24</td>
<td>0.061</td>
<td>0.427767</td>
</tr>
<tr>
<td>Ga-80</td>
<td>1.66</td>
<td>1.71</td>
<td>O-25</td>
<td>50ms?</td>
<td>0.16759</td>
</tr>
<tr>
<td>Ga-81</td>
<td>1.2</td>
<td>1.18</td>
<td>O-26</td>
<td>40ms?</td>
<td>0.076391</td>
</tr>
<tr>
<td>Ga-82</td>
<td>0.6</td>
<td>0.73</td>
<td>O-27</td>
<td>260ms?</td>
<td>0.03568</td>
</tr>
<tr>
<td>Ga-83</td>
<td>0.31</td>
<td>0.51</td>
<td>O-28</td>
<td>100ns?</td>
<td>0.01868</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Na-Isotopes</th>
<th>Exp. t_{1/2} in sec</th>
<th>Pred. t_{1/2} in sec (Fig-16)</th>
<th>As-Isotopes</th>
<th>Exp. t_{1/2} in sec</th>
<th>Pred. t_{1/2} in sec (Fig-17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na-28</td>
<td>0.0305</td>
<td>0.03657</td>
<td>As-68</td>
<td>180</td>
<td>180</td>
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<tr>
<td>Na-29</td>
<td>0.0449?</td>
<td>0.01036</td>
<td>As-69</td>
<td>900</td>
<td>902</td>
</tr>
<tr>
<td>Na-30</td>
<td>0.0484?</td>
<td>0.00203</td>
<td>As-70</td>
<td>3180</td>
<td>3187</td>
</tr>
<tr>
<td>Na-31</td>
<td>0.0177</td>
<td>0.00123</td>
<td>As-71</td>
<td>219,600</td>
<td>17.962</td>
</tr>
<tr>
<td>Na-32</td>
<td>0.0129</td>
<td>0.000472</td>
<td>As-72</td>
<td>263,109?</td>
<td>384,421</td>
</tr>
<tr>
<td>Na-33</td>
<td>0.0082</td>
<td>0.000228</td>
<td>As-73</td>
<td>6,937,920</td>
<td>6,954,262</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ir-Isotopes</th>
<th>Exp. t_{1/2} in sec</th>
<th>Pred. t_{1/2} in sec (Fig-18)</th>
<th>Ir-Isotopes</th>
<th>Exp. t_{1/2} in sec</th>
<th>Pred. t_{1/2} in sec (Fig-19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ir-178</td>
<td>12</td>
<td>26.249</td>
<td>Ir-180</td>
<td>90</td>
<td>141.507</td>
</tr>
<tr>
<td>Ir-179</td>
<td>79</td>
<td>49.764</td>
<td>Ir-181</td>
<td>300</td>
<td>296.088</td>
</tr>
</tbody>
</table>

Plotting ln t_{1/2} for ^{24}\text{Na} - ^{28}\text{Na} versus ln(E_b/\Delta UQM_n) gives the following correlation:

\[ \ln \left( \frac{t_{1/2}}{t_{1/2}} \right) = 7.2095 \ln \left( \frac{E_b}{\Delta UQM_n} \right) - 110.04, \quad R^2 = 0.9929 \]  

(38) (see Fig-16)

Plotting ln t_{1/2} for ^{68}\text{As} - ^{73}\text{As} versus ln(E_b/\Delta UQM_n) gives the following correlation:

\[ \ln \left( \frac{t_{1/2}}{t_{1/2}} \right) = 8.3752 \ln \left( \frac{E_b}{\Delta UQM_n} \right) - 127, \quad R^2 = 1.00 \]  

(39) (see Fig-17)

Plotting ln t_{1/2} for ^{181}\text{Ir} - ^{185}\text{Ir} versus ln(E_b/\Delta UQM_n) gives the following correlation:

\[ \ln \left( \frac{t_{1/2}}{t_{1/2}} \right) = 6 \times 10^{-7} \ln \left( \frac{E_b}{\Delta UQM_n} \right) - 2.1339, \quad R^2 = 0.9914 \]  

(40) (see Fig-18)

Table-6 lists the estimated half-life’s isotopes for these four elements. Table-7 shows the data for equations 37-40 and Figures-15-18 show the correlations among their nuclear data (See Appendix-A).

3.6. Atomic Mass Prediction of Isotopes from Mass Quantization Principle

The correlation of UQM_{n} of an isotope’s nuclides with the mass number A can predict the atomic mass M_{A} of any non-existant nuclides that cannot be prepared, or it is of very short half-life isotope. For example the predicted atomic masses M_{A} of \text{^9He} and \text{^10He} isotope are 9.05811692863621 and 10.0718982330674 u as seen below. Plotting UQM_{n} versus mass number A for helium isotopes gives the following correlation:

\[ \text{UQM}_{n} = 0.012 \ln(A) + 0.9794, \quad R^2 = 0.9909 \]  

(41) (see Fig-19)

When A=10, the UQM_{n} is equal to 1.007031021116 u. The M_{A} is given by M_{A}=ZM_{H} + NUQM_{n} which equals to 2 \times 1.00782503207 + 8 \times 1.007031021116 or M_{A}= 10.0718982330674 u. The atomic mass M_{A} evaluation of IAEA has estimated the mass of \text{^9He} and \text{^10He} isotope to be 9.04395 u and 10.05240 u respectively. The estimated M_{A} for non-existant \text{^11He}, \text{^12He}, and \text{^13He} are 11.091265844338 u, 12.109041893555 u, and 13.12762337932480 respectively. Another example: the predicted atomic mass M_{A} of \text{^21C} isotope is 21.0516663702875 u as seen below. Plotting UQM_{n} versus mass number A for carbon isotopes gives the following correlation:

\[ \text{UQM}_{n} = 0.0138 \ln(A) + 0.9583, \quad R^2 = 0.9916 \]  

(42) (see Fig-20)
When A=21, the UQM\textsubscript{n} is equal to 1.000314409641 u. The M\textsubscript{A} is given by M\textsubscript{A}=ZM\textsubscript{H} + NUQM\textsubscript{n} which equals to 6 x 1.00782503207 + 15 x 1.000314409641 or M\textsubscript{A}=21.0518770451 u.

The atomic mass evaluation of IAEA has estimated the mass of $^{21}$C isotope to be 21.049340 # (Values marked # are not purely derived from experimental data, but at least partly from systematic trends).

Another example: the predicted atomic mass of $^{23}$N isotope is 23.0518770451 u. Plotting UQM\textsubscript{n} versus mass number A for nitrogen isotopes gives the following correlation:

$$UQM_n = 0.0149 \ln(A) + 0.9531, \ R^2 = 0.9873$$

(43) (see Fig-21)

Another example: the predicted atomic mass of $^{219}$Po isotope is 219.027628516413 u. Plotting UQM\textsubscript{n} versus mass number A for polonium isotopes gives the following correlation:

$$UQM_n = 0.0132 \ln(A) + 0.9242, \ R^2 = 0.9978$$

(44) (see Fig-22)

The atomic mass evaluation of IAEA has estimated mass of $^{219}$Po isotope to be 219.0135170 # u. The atomic masses for $^{220}$Po also estimated to be 220.031142865092 u {compared to: 220.016382(39)#}. Another example: the predicted atomic mass of $^{225}$U isotope is 225.00303092166 u. Plotting UQM\textsubscript{n} versus mass number A for Uranium isotopes gives the following correlation:

$$UQM_n = 0.0118 \ln(A) + 0.9307, \ R^2 = 0.9978$$

(45) (see Fig-23)

Another example: the predicted atomic mass of $^{225}$U isotope is 225.02939 #. The atomic mass evaluation of IAEA has estimated mass of $^{231}$Am isotope is 231.03163493494 u. Plotting UQM\textsubscript{n} versus mass number A for Americium isotopes gives the following correlation:

$$UQM_n = 0.011 \ln(A) + 0.9349, \ R^2 = 0.9993$$

(46) (see Fig-24)

The atomic mass evaluation of IAEA has estimated mass of $^{231}$Am isotope to be 231.04556(32)#. The atomic masses for $^{232}$Am and $^{244}$Am are also estimated to be 232.0329112591 u {compared to: 232.04659(32)#} and 244.0533367613 u {compared to: 244.0642848(22)} respectively.

Table-8 shows the QM\textsubscript{n} values for the calculated isotopes (See Appendix-A).

**Figure-19:** The UQM\textsubscript{n} values of He isotopes against their Mass Numbers A, \ln(A)

![Figure-19](image)

**Figure-20:** The UQM\textsubscript{n} values of Carbon isotopes against their Mass Numbers A, \ln(A)

![Figure-20](image)

**Figure-21:** The UQM\textsubscript{n} values of Nitrogen isotopes against their Mass Numbers A, \ln(A)

![Figure-21](image)

**Figure-22:** The UQM\textsubscript{n} values of Polonium isotopes against Mass Numbers A, \ln(A)

![Figure-22](image)
3.7. The Radioactivity of the Isobar and Isotope from the Mass Quantization Principle

A- Isobar Radioactivity

As we explained previously in items 3.2 and 3.3 that negatron/positron-energy, $E_{\beta}$ is directly proportional to the mass increment $\Delta m$ of the neutron $\Delta UQM_{n}(u)$ in the consecutive isobar series while the half-life $t_{1/2}$ is inversely proportional to mass increment of the neutron in the isobar. The radioactivity $A$ (dps) of the isobar in the reactor can be calculated from beta-energy $E_{\beta}$, half-life $t_{1/2}$, and the $\Delta UQM_{n}$ rather than $\Delta m$ as seen the following equations:

$$E_{\beta} \propto \Delta UQM_{n} \text{ (and } \propto Z \text{ and } A \text{ mainly plus slight factors like parity and shape of nuclide) } \quad (47)$$

$$t_{1/2} \propto \frac{1}{\Delta UQM_{n}} \text{ (and } \propto Z \text{ and } A \text{ mainly plus slight factors like binding energy,) } \quad (48)$$

The slight factors will not constitute more than few percent as an average. We can express the effect of $A$ and $Z$ by a so-called decay attenuation factor $g$, where

$$g \left( \lambda \frac{A}{N} \right) = \frac{A_{i}^{*}(Z)^{0.5}}{(N)^{2}}. \quad (50)$$

This factor will be inserted in the equation to give more accurate results which might exceed the 98% level of the confidence. SMT theory depends on the time-dependent general formula of activity of the many successive decays:

$$\frac{dN_{n}}{dt} = \lambda_{n-1}N_{n-1} - \lambda_{n}N_{n} \quad (49)$$

which is solved by Bateman equations\textsuperscript{36} for calculation of the radioactivity of the isobars. However, NMT derived a novel formula linking between the radioactivity and beta-energy $E_{\beta}$, half-life $t_{1/2}$, and $\Delta UQM_{n}$ factors using $A=\lambda N$ (or $A=A^{0}e^{-\lambda t}$) to estimate the radioactivity from these factors in nuclear reactor for monitoring the produced radioactivity and to identify the radioactive species. The $\Delta UQM_{n}$ was calculated from $UQM_{n}$ of the neutron in the radioactive isobar and $QM_{n}$ of the neutron in the stable isotope (for example, $UQM_{n}$ in the $^{157}$Eu and $QM_{n}$ in $^{153}$Eu).

$$\frac{E_{\beta}}{t_{1/2}} = \frac{g}{931.5} \left( \frac{MeV}{u} \right) x A \text{ (dps)} x \Delta UQM_{n} \left( u \right). \quad (50)$$

$$A \text{ (dps)} = \frac{E_{\beta} x g}{931.5 \times t_{1/2} \times \Delta UQM_{n}} \times N_{n} \text{ per one nuclide.} \quad (51)$$

Where $N_{n}$ is the number of neutrons in the isobar, or;

$$A \text{ (dps)} = \frac{E_{\beta} x g}{931.5 \times t_{1/2} \times \Delta UQM_{n}} \times \frac{N}{M_{A}} \text{ per one gram.} \quad (52)$$

NMT may estimate the weight of the produced isobar in the reactor from its beta energy and the $\Delta UQM_{n}$ (u), where $N$ is number of nuclides (where $N=A/\lambda$), $N_{i}$ is Avogadro constant ($6.022045 \times 10^{23}$ mol$^{-1}$), and $M_{A}$ is the nuclide mass (in unified atomic mass units u, where 1u=1 g/mol) as follow;

$$W \text{ (grams)} = \frac{N \times M_{A}}{N_{i}} = \frac{A \text{ (dps)} \times M_{A} \times t_{1/2}}{N_{i} \times 0.693} \quad (53)$$

Using eq.no 52 for $A \text{ (dps)}$ we get

$$m \text{ (grams)} = \frac{E_{\beta} x g x N}{0.693x931.5 \times \Delta UQM_{n}} = 1.549 \times 10^{-1} \frac{E_{\beta} x g \times N}{\Delta UQM_{n}} \quad (54)$$

For example, we can calculate the radioactivity of the $^{137}$Te isobar series as seen below:

\textsuperscript{36} We defined previously that the $\Delta UQM_{n}= UQM_{n}-QM_{n}$ where the $UQM_{n}$ refers to the mass of the neutron in the radioactive isotope and the $QM_{n}$ refers to the mass of the neutron in the stable isotope. (See page 33)

\textsuperscript{36} $N_{D} = \frac{N_{i}}{\lambda_{D}} \sum_{i=1}^{D} C_{i} e^{-\lambda_{i}t}$ where $C_{i} = \prod_{j=1}^{D} \frac{\lambda_{j}}{\lambda_{j} - \lambda_{i}}$
The radioactivity of the isotopes in the nuclear reactor can be calculated from equation no. 52 using IAEA data to get $\Delta UQM_{\text{ref}}$. We will compare our results with the radioactivity values calculated from $A=N_\lambda$, where $N=N_\lambda/M_A$. We have calculated the activity of the $^{157}\text{Eu}$ from Bateman equations after $t=600$ s and 6000 s to be $4.874177 \times 10^{16}$ and $4.55179 \times 10^{16}$ respectively which are very close to the 4.8651619 x $10^{16}$ that calculated from $A=N_\lambda/M_A$. Therefore we adopted the values of the standard formula $A=\lambda N_\lambda/M_A$ to calculate the reference values for purpose of comparison avoiding the complication of Bateman equations.

For example, the calculated radioactivity from eq-52 for $^{137}\text{Xe}$, $^{52}\text{Te}$, $^{93}\text{Sr}$, and $^{93}\text{Yr}$ are compared with $A=\lambda N_\lambda/M_A$ values as follow:

- The radioactivity $A$ of $^{137}\text{Xe} = 1.2945399 \times 10^{19}$ dps per one gram, compared to (1.3305222 x $10^{19}$)
- The radioactivity $A$ of $^{137}\text{Te} = 2.6900462 \times 10^{20}$ dps per one gram, compared to (4.6332833 x $10^{20}$)
- The radioactivity $A$ of $^{93}\text{Sr} = 1.4175370 \times 10^{19}$ dps per one gram, compared to (1.0077610 x $10^{19}$)
- The radioactivity $A$ of $^{93}\text{Yr} = 1.6570508 \times 10^{17}$ dps per one gram, compared to (1.2247233 x $10^{17}$)

The calculated radioactivity from the standard formula $A=\lambda N_\lambda/M_A$ will help in estimation of either the energy or the half-life of the isobar. For example the calculated radioactivity for $^{174}\text{Er}$ (using $A=\lambda N_\lambda/M_A$, at $t_{1/2}=3.2$ min) is 1.249876 x $10^{19}$ dps, this will give $E_\beta=3.008$ MeV (compared with 2.0 MeV (NBL), 3.327 MeV (K&L)). The derived empirical beta energy formula eq. no. 55

$$E_\beta=0.693 \times 931.5 \times \Delta UQM_{\beta}/g$$  \hspace{1cm} (55)

might also be used also for estimation of beta energies in nuclear reactor, based on the difference of neutron mass quantization, to get a rough assessment to the released energies. It gave good values for some isotopes as seen below in Table-9.

| Table-9: The estimated beta energies from the empirical formula $E_\beta=0.693\times931.5\times\Delta UQM_{\beta}/g$ |
| --- | --- | --- | --- | --- | --- | --- |
| Isotope | Experimental | Calculated | Isotope | Experimental | Calculated |  |
| $^{21}\text{O}$ | 8.096 | 7.918 | $^{39}\text{S}$ | 6.638 | 6.668 |  |
| $^{41}\text{Ar}$ | 3.108 | 3.146 | $^{94}\text{Sr}$ | 3.508 | 3.541 |  |
| $^{97}\text{Nb}$ | 1.935 | 1.956 | $^{127}\text{Sn}$ | 3.201 | 3.159 |  |
| $^{168}\text{Dy}$ | 1.50 | 1.54 | $^{173}\text{Yb}$ | 1.298 | 1.384 |  |

We noticed that the error increases with short half-life nuclides due to the inaccuracy of the experimental measurement of their half-lives. NMT understands that the nuclides in the nuclear reactor are open systems which mean some of released magnetons packages attack the other nuclides which increase their masses and energies. Therefore, the energy released from the isobar exceeds the mass defect. This phenomenon increase the difficulty in finding the accurate radioactivity for the isobars and isotopes in the nuclear reactors through their $E_\beta$ and $t_{1/2}$ values but still this Eq.52 gives high accurate results. (More examples are worked in Table-10 in Appendix-A).

**B- Isotope Radioactivity**

The equation no. 52 can be used for calculation of the radioactivity of $\beta^+/\beta^-$-emitter isotopes using the $\Delta UQM_{\beta}$ (see page 32 for definition $\Delta UQM_{\beta}$) for isotopes as follow:

The calculated radioactivity for some isotopes is compared with $A=\lambda N_\lambda/M_A$ values as follow:

- The radioactivity $A$ of $^{21}\text{O} = 5.9388043 \times 10^{21}$ dps per one gram, compared to (5.8120 x $10^{21}$)
- The radioactivity $A$ of $^{33}\text{Si} = 2.2675002 \times 10^{21}$ dps per one gram, compared to (2.04677 x $10^{21}$)
- The radioactivity $A$ of $^{39}\text{S} = 9.2452512 \times 10^{20}$ dps per one gram, compared to (9.28883 x $10^{20}$)
- The radioactivity $A$ of $^{44}\text{Ar} = 1.3167962 \times 10^{19}$ dps per one gram, compared to (1.33312 x $10^{19}$)
- The radioactivity $A$ of $^{94}\text{Sr} = 5.8466044 \times 10^{18}$ dps per one gram, compared to (5.90264 x $10^{18}$)

This approximate radioactivity of the isotope may help in identification of the produced isotope in the reactor. These equations are very sensitive to the input data for isobars and isotopes. The
accuracy of the results depends on the accuracy of the used data for the energy and half-life’s values. More examples are worked in Table-11 in Appendix-A

4. Neutron Mass Quantization Application for Calculation of Q-value of Nuclear Decays and Reactions

As clarified in previous sections above, all nuclear decay and reaction are based on the changes in neutron masses, in the mother and the daughter, as the neutrons have various quantized masses contrary to protons and electrons, which have one certain quantized mass. NMT adopted a neutron mass defect $\Delta M_n$ concept, based on mass quantization, instead of the normal mass defect $\Delta M_A$, and $E=mbc$ to calculate the Q-value, instead of $E=mc^2$. The general formula for $\Delta M_n$ can be written as follow:

The total mass of the neutron in the nuclide $= M_A - Z M_H$, where $M_A$= the spectroscopic mass of the nuclide. In calculation of $\Delta M_n$ we used $M_H$, and the general formula is given as follows:

$$(NMT) \Delta M_n = \Sigma (M_A - Z M_H)_{\text{left-side}} - \Sigma (M_A - Z M_H)_{\text{right-side}} \tag{56}$$

Equation-56 uses Mass-Energy Conformity Principle. For example, the total mass of neutron in $^2_1 \text{D}$ can be calculated from this formula $(M_A - Z M_H)$. The mass of $^2_1 \text{D}$-nuclide is equal to $2.014101778$ u. We deduct the $^1_1 \text{H}$ mass $M_H$ of $1.007825032$ u to get mass of neutron inside this nuclide which is equal to $1.006276746$ u. In a similar manner, we calculate the mass of neutrons in a different nuclide. The total mass of a neutron in $^3_1 \text{T}$ is equal to $1.004112118$ u which can be calculated like this $(3.016 049268 - 1.007825032 = 2.008224236)$. The Q-value for any nuclear process is given by $Q\text{-value}= \Delta M_n \times 194.177$ MeV/bc (or $\times 931.5$ MeV/$c^2$ for purpose of comparison) with consideration of the following points:

a) In positron decay, we add $2M_e$ to right hand side and we add the mass of the proton to total neutron mass in mother nuclide. In negatron and EC decays, we neglect $M_e$.

b) In all type of nuclear processes, the neutron will be considered in the total mass as a separate particle to conserve the mass.

c) In all type of nuclear processes, the proton will not be used as a separate particle because it will be included in $Z$ and $M_A$. In a few fission reactions, the proton and the electron will be used to conserve the mass and the charge.

d) In all type of nuclear spallation processes, when the proton is the projectile and the neutron is the ejectile, $X(p,n)Y$, we will add $(M_n - M_H)\times 194.177$ MeV/bc to right side (or $0.782352$ MeV/$c^2$) and we increase the $Z$ of the target by one i.e. $(M_A - Z M_H)$ (see eq. 67&68). That means we will subtract $0.782352 \text{ MeV}/c^2$ from total Q-value.

The neutron mass defect $\Delta M_n$ concept is different from the mass defect $\Delta M_A$ concept of the Standard Model Theory, SMT, which states that the mass defect $\Delta M_A$ is converted to energy. The mass defect $\Delta M_A$ of SMT uses both $M_H$ and $M_n$:

$$(SMT) \text{Mass defect}^{37} \Delta M_A = M_A - (Z M_H + N M_n) \tag{57}$$

Equation-57 uses Mass-Energy Equivalence Principle. Where $M_H= 1.00782503207$ u and $M_n=1.008664916$ u. Therefore, there is a big difference between $\Delta M_n$ and $\Delta M_A$.

The neutron mass defect $\Delta M_n$, which is based on the mass quantization principle, and the Mass-Energy Conformity Principle are new concepts in nuclear science and considered as the main premise of NMT which used in the nuclear calculations.

The main concept here is that the magnetons generate energy due to their spinning and rotation movements inside the neutron and the protons in the nucleus thus creating Strong Charged Electromagnetic Force (SCEF) with self-gravity force, SGF. Each magneton or antimagneton will

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37 Mass defect is different from mass excess which is given by $\delta_A = M_A - A$ where it is commonly used by the tables of isotopes.
generate energy equal to 0.0521141 eV based on \( E=mb c \) (or 0.25eV based on \( E=mc^2 \) for purpose of the comparison with literature’s nuclear values and data) in accordance to the **Mass-Energy Conformity Principle**, as we explained it in previous paragraph where \( E=mbc \) gives 194.177 MeV/bc to each one atomic mass unit. This principle states that the amount of the energy created is equivalent to the summation of the mass of the spinning-rotating magnetons.

Consequently, when some of these packages of magnetons go outside of the neutron texture to the surroundings, they will be accompanied by their nuclear energy emitted as gamma-rays. Each nuclide will emit its type of packages (each package has different numbers of magnetons) of magnetons which finally disintegrate into discrete magneton or its antimagnet or both. Different experiments give different types of measurement for these magnetons packages which cause confusion as there is an oscillation which happened at Super-Kamiokande and Sudbury Neutrino Observatory. NMT predicts that each type of nuclear reaction emits a specific type of a package of magnetons as a finger print.

All types of nuclear spontaneous and induced reactions are accompanied by releasing magnetons (neutrinos). The calculated Q-values are rounded to 5 digits to keep the accuracy. We will use the following terms: \( \Delta M_n = \) the neutron mass defect, \( M_A = \) atomic mass which includes orbital electrons masses, \( M_n = \) mass of free neutron, 1.008664916 u, as it is needed in calculation of binding energy, \( M_H = \) (mass of proton including \( M_e \) i.e. 1.00782503207 u), \( M_e = \) mass of electron, and the symbol \( Z = (Z-1), Z_e=(Z+1) \). The **Q-value can be calculated from \( \Delta M_n \times 194.177 \text{ MeV/bc from non-relativistic}^{38} \), which is adequate to describe the actual **Q-value**, or \( \Delta M_n \times 931.49406121 \text{ MeV/c}^2 \) relativistic for purpose of comparison with the literature’s values.

### 4.1. Q-Value of Nuclear Decay and Reactions

The **neutron mass defect** \( \Delta M_n \) is used in the calculation of the Q-value for nuclear decay reactions as follow. The literature data references for these decays, \( \beta^- \), \( \beta^+ \), EC and other calculations is from above mentioned sources\[83-89\]. In Appendix-B, we worked some examples to show the details of the calculation.

**I- \( \beta^- \)-decay Q-value**

The Q-value of \( \beta^- \)-decay can be calculated from the neutron mass defect \( \Delta M_n \) in the parent or mother M and in the daughter D. In this type of decay, one neutron converts to proton and electron to achieve the neutron quantized mass in the daughter nuclide with help of the conservon\( d \). Thus, we have to add the mass of the proton to the total neutron mass in the daughter nuclide in right side to be \( (M_A-Z_1 M_H) \) One electron will be released as beta ray and one electron will be acquired from the surroundings to neutralize the new born proton; the total electron balance remains constant. The general formula of \( \Delta M_n \) for \( \beta^- \)-decay is given by:

\[
\Delta M_n = [(M_A-Z_1 M_H)_M - (M_A-Z_1 M_H)_D]
\] (58)

The term \( (M_A-Z_1 M_H)_M \) and \( (M_A-Z_1 M_H)_D \) will give the total mass of neutrons in the mother M and the daughter D respectively. For example, the Q-value for \( ^{239}_{93}Np \) \( \beta^- \)-decay can be calculated like this (see Appendix-B for more details):

\[
^{239}_{93}Np \rightarrow ^{239}_{94}Pu + e^- + \bar{\nu}_e \ (0.7225 \text{ MeV/c}^2, \text{from literature})
\]

\( \Delta M_n \) in neutron mass (neutron mass defect) on both sides is 0.0007756 u. The Q-value is 0.7225 MeV/c\(^2\) (based on 931.5 MeV/c\(^2\) relativistic) or 0.1506 MeV/bc (based on 194.177 MeV/bc, non-relativistic). (See Appendix-B for more details).

**II- \( \beta^+ \)-decay Q-value**

The Q-value of \( \beta^+ \)-decay can be calculated from the neutron mass defect \( \Delta M_n \) in the mother M and in the daughter D. In this type of decay, one proton is converted to neutrons with help of

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38 In nuclear weapons as well as in nuclear reactors, that efficiency figure is typically on the order of a few percentage points (though efficiencies as high as 40% have been achieved). The efficiency of the “Little Boy” weapon that was used against Hiroshima in 1945 was very low and below \( E=mc^2 \) value.
conservon; and one electron and one positron will be released out. Thus, we have to add the mass of the proton to the total neutron mass in mother nuclide in left side to be \((M_A - Z) M_H\), and we have to add two electrons’ mass to right side to total neutrons mass. The general formula of \(\Delta M_n\) for \(\beta^+\)-decay is given by:

\[
\Delta M_n = [(M_A - Z) M_H]_{M} - \{(M_A - Z) M_H\}_{D} + 2M_e]
\]

For example, the Q-value for \(^{22}\text{Na}\) \(\beta^+\)-decay can be calculated like this (see Appendix-B for more details):

\(^{22}\text{Na} \rightarrow ^{22}\text{Ne} + e^+ + \nu_e \) (Total = 1.8203 MeV, from literature)

\(\Delta M_n\) in neutron mass on both sides is 0.001955152 u. The Q-value is 1.8203 MeV/c^2 or 0.3795 MeV/\(\text{bc}\). SMT value is 1.82027 MeV/c^2. (See Appendix-B for more details).

III- EC-decay Q-value

In electron capture decay, one of the protons picks up one electron from atomic orbitals to convert into neutron with help of conservon and to achieve the neutron quantized mass in the daughter. Therefore, the total electron balance remains constant. We have to add the mass of the proton to the total neutron mass in mother nuclide in left side to be \((M_A - Z) M_H\). The general formula of \(\Delta M_n\) for EC-decay is given by:

\[
\Delta M_n = \{[(M_A - Z) M_H]_{M} - [(M_A - Z) M_H]_{D}\}
\]

For example, the Q-value for \(^{189}\text{Ir}\) EC-decay can be calculated like this (see Appendix-B for more details):

\(^{189}\text{Ir} + e \rightarrow ^{189}\text{Os} + \nu_e \) (Total = 0.5324 MeV/c^2, from literature)

\(\Delta M_n\) in neutron mass on both sides is 0.0005715 u. The Q-value is 0.53235225 MeV/c^2 or 0.11097 MeV/bc. SMT value is 0.53235 MeV/c^2. (See Appendix-B for more details).

IV- Alpha-decay Q-value

In \(\alpha\)-decay, two protons and two neutrons are emitted from the heavy nuclide together as \(\alpha\) particle. The general formula of \(\Delta M_n\) for \(\alpha\)-decay is given by:

\[
\Delta M_n = \{[(M_A - Z) M_H]_{M} - [(M_A - Z) M_H]_{D} + (M_A - Z) M_H\}_{\alpha}\}
\]

\(^{239}\text{Pu} \rightarrow ^{235}\text{U} + \alpha \) (Total = 5.245 MeV/c^2, from literature)

\(\Delta M_n\) in neutron mass on both sides is 0.0056302459 u. The Q-value is 5.2446 MeV/c^2 or 1.09753 MeV/bc. SMT value is 5.245 MeV/c^2. (See Appendix-B for more details).

V- Cluster-decay Q-value

In cluster-decay, different products of nuclides are emitted from the heavy nuclide. The general formula of \(\Delta M_n\) for cluster-decay is given by:

\[
\Delta M_n = \{[(M_A - Z) M_H]_{M} - \sum [(M_A - Z) M_H]_{D}\}
\]

\(^{228}\text{Ra} \rightarrow ^{208}\text{Pb} + ^{14}\text{C} \)

\(\Delta M_n\) in neutron mass on both sides is 0.0341700623 u. The Q-value is 31.82941 MeV/c^2 or 6.635 MeV/\(\text{bc}\). SMT value is 31.8294 MeV/c^2. (See Appendix-B for more details).

\(^{228}\text{Th} \rightarrow ^{208}\text{Pb} + ^{20}\text{O} \)

\(\Delta M_n\) in neutron mass on both sides is 0.0480123 u. The Q-value is 44.72346 MeV/c^2 or 9.323 MeV/\(\text{bc}\). SMT value is 44.7235 MeV/c^2. (See Appendix-B for more details).

4.2. Q-Value of Nuclear Fusion Reactions

The neutron mass defect \(\Delta M_n\) is used too in the calculation of the Q-value for nuclear fusion reactions as follows. The calculation of the Q-value is based on the mass changes in the neutrons (neutron mass defect and not normal mass defect) in nuclides on both sides. For example the Q-value for \(^3\text{T}(d,n)\) \(^4\text{He}\) reaction can be calculated as follows.
\[ \Delta M_n = \sum (M_A - ZM_H)_R - \sum (M_A - ZM_H)_P + M_x \], x= any particle released, \( R=\text{react}, P=\text{prod} \)  
\[ ^2D + ^6Li \rightarrow ^4He(3.5\text{MeV}) + n'(14.1\text{MeV}) \]  
(Total=17.589 MeV/c^2, from literature)

\[ \Delta M_n \] in neutron mass on both sides is 0.0188828854 u. T he Q-value is 17.589 MeV/c^2 or 3.663 MeV/bc. SMT value is 17.589 MeV/c^2 (See Appendix-B for more details).

The fusion reaction of \( ^2D \) with \( ^6\text{Li} \) gives different products as seen below:

1. \( ^2D + ^6\text{Li} \rightarrow ^4\text{He} + 22.4\text{MeV} \)

\( \Delta M_n \) in neutron mass on both sides is 0.0240180645 u. T he Q-value is 22.37283 MeV/c^2 or 4.6637 MeV/bc. SMT value is 22.373 MeV/c^2 (See Appendix-B for more details).

2. \( ^2D + ^6\text{Li} \rightarrow ^1\text{Li} + ^7\text{Li} + + + 5.0\text{MeV} \)

\( \Delta M_n \) in neutron mass on both sides is 0.00539505601 u. T he Q-value is 5.0255 MeV/c^2 or 1.0476 MeV/bc. SMT value is 5.0255 MeV/c^2 (See Appendix-B for more details).

4.3. Q-Value of Nuclear Fission Reactions

When the thermal or fast neutron attacks the heavy nuclide, the result will be a splitting into two smaller lighter nuclei. The mass of the released neutron mostly covers the range between UQM\(_n\) of \( ^{236}\text{U} \) (0.99531712 u) and the free neutron (1.008664916 u). The neutron mass defect, \( \Delta M_n \) is used in calculation of Q-value for fission reactions as follows.

A-The general formula of \( \Delta M_n \) for primary fission reaction, without late \( \beta^- \)-decay, is given by:
\[
\Delta M_n = [\{ (M_A - ZM_H)_f + M_n \} - \{ \sum (M_A - ZM_H)_P + xM_n \}], x=\text{No of neutron released, } f=\text{fission products,} \]  
\[
n + ^{235}\text{U} \rightarrow ^{92}\text{Kr} + ^{141}\text{Ba} + 3n \]  
(173.29 MeV/c^2)

\( \Delta M_n \) in neutron mass on both sides is 0.1860330680 u. T he Q-value is 173.289803 MeV/c^2 or 36.251 MeV/bc. SMT value is 173.29 MeV/c^2 (See Appendix-B for more details).

\[
n + ^{235}\text{U} \rightarrow ^{94}\text{Zr} + ^{139}\text{Te} + 3n \]  
(172.840 MeV/c^2, from literature)

\( \Delta M_n \) in neutron mass on both sides is 0.1855505420 u. T he Q-value is 172.840 MeV/c^2 or 36.03 MeV/bc. SMT value is 172.84 MeV/c^2 (See Appendix-B for more details).

B- The general formula of \( \Delta M_n \) for fission reaction, with late \( \beta^- \)-decay, is given by:
\[
\Delta M_n = [\{ (M_A - ZM_H)_f + M_n \} - \{ \sum (M_A - ZM_H)_P + xM_n + y(M_H + M_e) \}], y=\text{No of beta particles,} \]  
\[
n + ^{235}\text{U} \rightarrow ^{90}\text{Y} + ^{143}\text{Pr} + 3n + 6\beta \]  
(191.274 MeV/c^2, from literature)

\( \Delta M_n \) in neutron mass on both sides is 0.20539788 u. T he Q-value is 191.2740 MeV/c^2 or 40.5114 MeV/bc. SMT value is 191.274 MeV/c^2 (See Appendix-B for more details).

Here we have to pay attention to the reaction of magnetons of high energy, which are released from fission reactions, with magnetons of the proton and neutron textures of uranium nuclides and fission products inside nuclear reactors which will release more gamma ray during the fission reaction. The above calculation is the net energy release from the neutron mass defect only \( \Delta M_n \). In section 4.7 we will discuss the open system calculation.

4.4. Q-Value of Nuclear Spallation Reactions at Accelerators

The calculation of the Q-value for inelastic nuclear reactions is based on the mass changes in the neutrons in nuclides on both sides. The general formula for these reactions is written as follow:

Target nucleus + projectile \( \rightarrow \) Final nucleus + ejectile + Q

Here are worked examples:

1. \( ^{10}\text{B} + p \rightarrow ^{12}\text{C} + \gamma(8.6913 \text{MeV}) \ldots \quad ^{10}\text{B}(p,\gamma)^{11}\text{C} \)
\[
\Delta M_n = (M_A - ZM_H)_R - (M_A - ZM_H)_P \]  
\[
\Delta M_n = 0.009328432 \text{u} \]
NMT Q-value is 8.68943 MeV/c² (1.8114 MeV/bc). SMT Q-value is 8.68943 MeV/c². Notice here that ¹⁰⁰B has 5 electrons and ¹¹C has 6 electrons therefore we have to add one electron to left side i.e. we use \( ^1_1H \) (=1.00782503207 u) rather than proton mass.

2. \( ^{11}_6B + p \rightarrow ^{11}_6C + n + (-2.7647 \text{ MeV}) \ldots \ldots ^{11}_6B(p,n)^{11}_6C \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R - (M_A-ZM_H)_P \right\} - (M_n-M_H) \)
\( \Delta M_n = -0.002968084 \text{ u} \)
NMT Q-value is -2.76477 MeV/c² (-0.576334 MeV/bc). SMT Q-value is -2.76477 MeV/c².

3. \( ^{12}_6C + p \rightarrow ^{12}_6C + n + p + (-18.7219 \text{ MeV}) \ldots \ldots ^{12}_6C(p,n)^{12}_6C \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R - (M_A-ZM_H)_P \right\} - (M_n-M_H) \)
\( \Delta M_n = -0.02009852 \text{ u} \)
NMT Q-value is -18.721768 MeV/c² (-3.902670 MeV/bc). SMT Q-value is -18.721768 MeV/c².

4. \( ^{14}_7N + p \rightarrow ^{11}_6C + ^4_2He + (-2.9221 \text{ MeV}) \ldots \ldots ^{14}_7N(p,\alpha)^{11}_6C \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R + (M_A-ZM_H)_P \right\} + (M_n-M_H) \)
\( \Delta M_n = -0.00313782 \text{ u} \)
NMT Q-value is -2.922877 MeV/c² (-0.60929 MeV/bc). SMT Q-value is -2.922877 MeV/c².

5. \( ^{10}_5B + ^3_2D \rightarrow ^{11}_6C + n + (6.4667 \text{ MeV}) \ldots \ldots ^{10}_5B(d,n)^{11}_6C \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R \right\} + (M_A-ZM_H)_P - (M_n-M_H) \)
\( \Delta M_n = 0.006940262 \text{ u} \)
NMT Q-value is 6.464854 MeV/c² (1.347639 MeV/bc). SMT Q-value is 6.464854 MeV/c².

6. \( ^{12}_6C + ^3_2He \rightarrow ^{11}_6C + ^4_2He + (1.8566 \text{ MeV}) \ldots \ldots ^{12}_6C(3^2He,\alpha)^{11}_6C \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R + (M_A-ZM_H)_P \right\} - (M_n-M_H) \)
\( \Delta M_n = 0.001992465 \text{ u} \)
NMT Q-value is 1.855981 MeV/c² (0.386891 MeV/bc). SMT Q-value is 1.855981 MeV/c².

7. \( ^{16}_8O + ^3_2He \rightarrow ^{18}_8F + p + (2.033 \text{ MeV}) \ldots \ldots ^{16}_8O(3^2He,p)^{18}_8F \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R + (M_A-ZM_H)_P \right\} - (M_n-M_H) \)
\( \Delta M_n = 0.0218090666 \text{ u} \)
NMT Q-value is 2.03152 MeV/c² (0.4235 MeV/bc). SMT Q-value is 2.03152 MeV/c².

8. \( ^{16}_8O + ^2_2He \rightarrow ^{18}_8F + p + n + (-18.5455 \text{ MeV}) \ldots \ldots ^{16}_8O(\alpha,pn)^{18}_8F \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R + (M_A-ZM_H)_P \right\} - (M_n-M_H) \)
\( \Delta M_n = 0.1991007429 \text{ u} \)
NMT Q-value is -18.546234 MeV/c² (-3.8661 MeV/bc). SMT Q-value is -18.546234 MeV/c².

9. \( ^{30}_14Si + p \rightarrow ^{28}_12Mg + 3p (-23.9927 \text{ MeV}) \ldots \ldots ^{30}_14S(p,3p)^{28}_12Mg \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R \right\} - (M_A-ZM_H)_P \)
\( \Delta M_n = 0.025756694 \text{ u} \)
NMT Q-value is -23.99236 MeV/c² (-5.001 MeV/bc). SMT Q-value is -23.99236 MeV/c².

10. \( ^{37}_17Cl + ^2_2He \rightarrow ^{38}_19K + 2n + (-4.182 \text{ MeV}) \ldots \ldots ^{37}_17Cl(3^2He,2n)^{38}_19K \)
\( \Delta M_n = \left\{ \{M_A-ZM_H\}_R + (M_A-ZM_H)_P \right\} + (M_n-M_H) \)
\( \Delta M_n = -0.04479123 \text{ u} \)
NMT Q-value is -4.172300 MeV/c² (-0.869743 MeV/bc). SMT Q-value is -4.172300 MeV/c² (see Appendix-B for more worked examples).

4.5. Q-Value of Nuclear Spontaneous Fission
The spontaneous fission has been observed only for nuclei with A>230. The neutron mass defect \( \Delta M_n \) is used in calculation of Q-value for spontaneous fission as follows. The general formula of \( \Delta M_n \) for spontaneous fusion reaction is given by:
\[ \Delta M_n = [(M_A - ZM_H)_b + xM_n], \text{f=fissile, P=products}; \]  
\[ ^{252}_{98}\text{Cf} \rightarrow ^{140}_{54}\text{Xe} + ^{108}_{42}\text{Ru} + 4n \ (200.41546 \text{MeV/c}^2, \text{from literature}) \]
\[ \Delta M_n \text{ in neutron mass on both sides is 0.2151534716 u. The Q-value is 200.41546 \text{MeV/c}^2 or 41.778 \text{MeV/bc}. \text{SMT value is 200.4155 \text{MeV/c}^2} \]  
\[ ^{254}_{104}\text{Rf} \rightarrow ^{140}_{62}\text{Sm} + ^{110}_{42}\text{Mo} + 4n + (201.94486 \text{MeV/c}^2, \text{from literature}) \]
\[ \Delta M_n \text{ in neutron mass on both sides is 0.216795336 u. The Q-value is 201.94486 \text{MeV/c}^2 or 41.778 \text{MeV/bc}. \text{SMT value is 201.9449 \text{MeV/c}^2} \]  

Finally, based on this new concept of neutron mass changes in the left and right sides, the Q-value can be calculated to any type or nuclear reaction. The released energy is due to emitted magnetons outside the nucleus as single magnetons, based on principle of conformity and not based on conversion of mass to energy.

### 4.6. Binding Energy Calculations

As we discussed in previous items, the four forces generated by the magnetons will mainly be used for binding the texture of the fermions and the remainder will be used in binding the fermions together inside the nucleus. At present time there is no clear criterion to determine how much of these forces will be used for binding energy \( E_b \). Although the liquid drop model’s simple equation of six empirically adjusted parameters succeeded in calculating the \( E_b \) for 1200 nuclides, it still has its limits. Anyhow, the conventional concept of the SMT stated that the \( E_b \) is calculated from the mass difference between the total free mass of protons and neutrons and the spectroscopic mass of the nuclide. This difference is called mass defect \( \Delta M_A \) and it is supposed to be converted into \( E_b \) using \( E=mc^2 \) speculative formula. Therefore, all nuclear measurement systems of SMT are setup based on this concept.

The NMT theory does not follow this mass-energy conversion but, rather, utilizes the mass quantization principle where the neutron shows its capability in having several quantized masses which are less than the mass of free neutron \( M_n \), which depends on the number of protons and neutrons in that nuclide. NMT theory sets a different novel conventional concept for calculating the \( E_b \) where it uses the neutron mass difference \( \Delta M_n \) between free neutron \( M_n \) and the neutron inside the nuclide \( (M_A-ZM_H) \). This \( \Delta M_n \) amount can be expressed as an energy unit based on the principle of conformity.

Of course, this new concept, neutron mass difference \( \Delta M_n \), gives an identical value for \( E_b \) calculated by SMT, but this does not mean the neutron mass defect that will convert into binding energy. Rather, it is a conventional criterion to estimate the nuclear energy SSNF generated from this mass amount of magnetons which equals to the energy needed to pry these nucleons apart. The general formula of \( \Delta M_n \) for binding energy calculation is given by the difference between mass of free neutron \( M_n \) and the mass of neutron inside the nuclide \( (M_A-ZM_H) \);

\[ \Delta M_n = N M_{n} - (M_A-ZM_H) \]  
(77)

The binding energy is given by \( E_b = (\Delta M_n/A) \times 194.177 \text{MeV/bc (non-relativistic) or} \times 931.5 \text{MeV/c}^2 \text{(relativistic) for purpose of comparison with literature.} \)

For example, the binding energy for \( ^2\text{T} \) can be calculated as follows:

\[ \Delta M_n = 0.00238816996 \text{ u. The binding energy is 2.22458 \text{MeV/c}^2 or} 1112.29016 \text{keV/A (based on} \]  
\[ 931.5 \text{MeV/c}^2 \text{relativistic) or} 0.463728 \text{MeV/bc. SMT value is 2.22458 \text{MeV/c}^2 (See Appendix-B for more details).} \]

Another example is the binding energy for \( ^{11}\text{T} \) which can be calculated as follows:

\[ \Delta M_n = 0.00910558633 \text{ u. The Binding Energy is 8.481854 \text{MeV/c}^2 or} 2827.28456 \text{keV/A (based on} \]  
\[ 931.5 \text{MeV/c}^2 \text{relativistic) or} 1.768095 \text{MeV/bc. SMT value is 2827.266 \text{keV/A (based on} \]  
\[ 931.5 \text{MeV/c}^2 \text{relativistic) (See Appendix-B for more details).} \]
4.7. Standard Energy of Formation of Nuclide SEFN and Q-Value

NMT noticed that some radionuclides in nuclear reactors, or similar environments, follow the thermodynamic of the open system properties\(^{39}\). The open system radionuclide emits quantity of energy exceeding the equivalent mass defect calculated by SMT. NMT explains this phenomenon: The fermion textures of these radionuclide are attacked by high energy packages of magnetons, released due to the fission reactions, which result in high excitation energy state system due to extra mass. The resulting excited radionuclide will emit energy exceeding the mass defect \(\Delta M_A\) or \(\Delta M_n\). In addition, the calculations based on mass defect cannot evaluate the energy deposition of prompt and delayed gammas, beta, and magneton packages (neutrinos) emission of the nuclear fission. Therefore, NMT tries to derive a formula based on QM\(_n\) to calculate the standard potential energy (latent energy) which is acquired by the nuclide during its formation to help in calculation of \(Q_T\)-value for all open-system processes happening in the nuclear reactors.

The calculation of the energy released by fission reaction is very complex. Although the Monte Carlo transport code MCNP5\(^{[90]}\) enables coupled neutron and gamma transport simulations, the final calculation cannot give the actual released energy and the total delayed heat \(Q_T\).

The \(Q_T\)-value is one of the main parameters required to evaluate the neutron flux of the reactor. The general equation for calculation of the neutron flux\(^{[91]}\) is:

\[
S\left[\frac{\text{neutrons}}{\text{sec}}\right] = \frac{P\left[\text{MW}\right]V\left[\text{neutron/fission}\right]}{1.6022 \times 10^{-19} \left[\frac{\text{MeV}}{\text{MJ}}\right] Q_T\left[\frac{\text{MeV}}{\text{fission}}\right]} \cdot k_{\text{eff}}
\]

Where:

\(S\) = number of neutrons being produced per second from fissioning.
\(P\) = total reactor power.
\(V\) = average number of neutrons produced per fission
\(k_{\text{eff}}\) = eigenvalue obtained from the reactor calculation \(\kappa = \eta \epsilon \rho f\)

The MCNP5 will provide the average neutron produced per fission per sec \(\bar{v}\) but \(Q_T\) remains the main issue to be calculated. The total fission \(Q_T\)-value is a mixture of energy contributions from fission product kinetic energy, prompt neutron kinetic energy, total prompt gamma energy, delayed neutron kinetic energy, total delayed gamma energy, energy released by electrons from beta decay, and the energy lost by magnetons (neutrinos).

The \(Q_T\)-value usually given by the following equation

\[
Q_T = Q_{fp} + Q_n + Q_{rp} + Q_{yd} + Q_{yc} + Q_\beta + Q_{\text{neutrino}}
\]

\(Q_{fp}\) = total energy released per fission [MeV / fission]
\(Q_n\) = energy released by the fission products [ca.167 MeV / fission]
\(Q_{rp}\) = energy released per prompt gamma [ca.6.5 MeV / fission]
\(Q_{yd}\) = energy released per delayed gamma [ca.6.5 MeV / fission]
\(Q_{yc}\) = energy released per capture gamma [ca.6.5 MeV / fission]
\(Q_\beta\) = energy released per beta decay [ca.6.5 MeV / fission]
\(Q_{\text{neutrino}}\) = energy released per neutrino [ca.11 MeV / fission]

Although the estimation of the \(Q_T\)-value is assumed to be independent of burnup fuel, reactor design, and reactor type, but it really relies on the burnup fuel. However, the literature from IAEA,

---

\(^{39}\) If the magnetons packages can be transferred from the surroundings to the system (i.e. the nuclide), or vice versa, the system is referred to as an open system (includes mass flow, work and heat). Otherwise, it is a closed system.
JAEA and NNDC shows different values for the QT due to different method used. For example, some textbooks recommend a QT-value for $^{235}$U of 195 MeV/fission$^{92}$, 190 MeV/fission$^{93}$, or 200 MeV/fission$^{94,95}$.

Table-12: QT-value data from ENDF-VII Tables (The results obtained from Los Alamos Lab website http://t2.lanl.gov. *{Does not include magnetons (neutrinos) energy}.

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Fission product + neutrons (MeV/fission)</th>
<th>Prompt gamma (MeV/fission)</th>
<th>Delayed gamma (MeV/fission)</th>
<th>Delayed beta (MeV/fission)</th>
<th>*Total (MeV/fission)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{235}$U</td>
<td>174.05</td>
<td>6.60</td>
<td>6.33</td>
<td>6.50</td>
<td>193.48</td>
</tr>
<tr>
<td>$^{238}$U</td>
<td>174.62</td>
<td>6.68</td>
<td>8.25</td>
<td>8.48</td>
<td>198.03</td>
</tr>
<tr>
<td>$^{239}$Pu</td>
<td>181.62</td>
<td>6.74</td>
<td>5.17</td>
<td>5.31</td>
<td>198.83</td>
</tr>
</tbody>
</table>

The current ENDF-VII reported fission Q-values and their components for $^{235}$U, $^{238}$U, and $^{239}$Pu are listed in Table-12. Experimental and theoretical research has been done on the relation between the average total fission fragment and the fission product kinetic energy ($Q_T$) of $^{235}$U, $^{238}$U, and $^{239}$Pu with energy of incident neutron$^{96-101}$. A detailed article by Madland (Theoretical Division, Los Alamos National Laboratory) has described the total prompt fission energy release and energy deposition, together with their components which have been determined as a function of the kinetic energy of the neutron inducing the fission for $^{235}$U, $^{238}$U, and $^{239}$Pu. It has been found that the energy release decreases somewhat with incident neutron energy and that the energy deposition changes slightly with incident neutron energy which is contrary to basic physical intuition$^{102}$. They found that the average total prompt fission energy deposition $E_d$ can be evaluated for the three systems under study as follows. For the $n + ^{235}$U system: $E_d = 180.57 + 0.1121E_n$ (MeV); for the $n + ^{238}$U system: $E_d = 181.04 + 0.1079E_n + 0.0042E_n^2$ (MeV); and for the $n + ^{239}$Pu system: $E_d = 188.42 + 0.0027E_n - 0.0017E_n^2$ (MeV). More recent and extended articles by Vogt (from LLNL) improved Madland study which calculated total energy release for $^{232}$Th, $^{235}$U, $^{239}$Pu, and $^{252}$Cf to be 180, 187.5, 190, 201, and 220 MeV respectively$^{103}$.

To calculate the QT-value in the reactors including all its partitions, NMT proposed a **standard energy of formation of nuclide** $E'_f$ (nucleosynthesis) as a new concept which is based on neutron mass quantization. As explained previously, the protons and the electrons are stable outside the nuclei and the atoms in the normal circumstances. In severe circumstances such as in the stars, the neutrons are usually generated from fusion of protons during the creation of nuclei. The energy released from this process during formation of the nucleus is called the standard energy of formation of nuclide, SEFN $E'_f$, (similar to standard enthalpy of formation $H'_f$ in chemistry). The released energy value corresponds to the actual latent (potential) energy received by the nuclide during the formation process. For example, for creation of He-4 nucleus in the stars, four protons will share the nuclear process where two protons fuse to create two neutrons i.e. $4p \rightarrow 2p + 2n^* + 2e^* + m^1(v_e)$ or $2p \rightarrow 2n^* + 2e^* + m^1(v_e)$, $n^*$ is either QM or UQM and is different from the free neutron.

The general formula for calculation of SEFN $E'_f$ is given by the difference between mass of free protons $NM^*_{p'}M^*_{p'}(=1.007276466812$ u, not $M_H$), and the corresponding produced N neutrons ($M^*_n$), (not $M_n$) in the generated nucleus, and N positrons released to environment. The mass of the produced neutrons inside the nuclide will be given by $NM^*_n=(M_A-ZM_H)$. Recall that $M^*_n$ equal to QM in stable nuclide and UQM in unstable nuclide (or $NM^*_p=M_A-ZM_H+2NM_e$ $E'_f^*+$. The general formula for $E'_f$ is:

$$E'_f = NM^*_{p'} - (NM^*_n+NM_e) \times 931.5 \text{ MeV} \quad (80)$$
This equation can be written in another mode, where \( N M_p^* - (N M_n^* + N M_e) = (M_A - Z M_H) + N M_e \) and after few substitutions to replace \( M_p^* \) by \( M_H \) and the \( M_n^* \) by \( (M_A - Z M_H) \) the final form is given as follows:

\[
E_f^o = A M_H - (M_A + 2 N M_e) \times 931.5 \text{ MeV} \tag{81}
\]

Where \( A \) = mass number, \( M_H = 1.00782503207 \text{ u} \), \( M_e = 0.0005485799095 \text{ u} \), and \( M_A \) value is from the nuclear data tables. The energy of two electrons \( 2 M_e \) in Eq-81 will be saved as latent energy in the nuclide which serves in estimation of \( Q \) value for the open systems. For example, the standard energy of formation \( E_f^o \) of \( ^4 \text{He} \) can be calculated from Eq.81 \([4 \times 1.007825032 - (4.0260325413 + 2 \times 0.0005485799095)] \) or from Eq.80 \([2 M_p^* - (2 M_n^* + 2 M_e)] \), i.e. \([2 \times 1.007276466812 - (2 \times 0.993476593 + 2 \times 0.0005485799095)] \) which is equal to 0.026502415 u or \( 5.14615941 \text{ MeV/c}^2 \) (based on \( 194.177 \text{ MeV/bc} \), non-relativistic) or \( 24.6870 \text{ MeV/c}^2 \) (where the mass of two neutrons \( 2 M_n^* = (M_A - Z M_H)/N \) came from the nuclide mass \( M_A \) measured by mass spectroscopy). Eq. 81 shows that the SEFN \( E_f^o \) of \( ^4 \text{He} \) is more energetic than \( ^3 \text{T} + ^1 \text{H} \rightarrow ^4 \text{He} + 19.814 \text{MeV} \). Other examples are \( E_f^o \) for \( ^3 \text{He} \) is 5.913712 MeV/c\(^2 \), \( E_f^o \) for \( ^3 \text{T} \) is 4.873137, and \( E_f^o \) for \( ^2 \text{D} \) is 0.420235 MeV/c\(^2 \). The \( E_f^o \) values explain why the regions in the stars produce \( ^3 \text{T} \) and \( ^3 \text{He} \), are colder than those that produce \( ^4 \text{He} \). The SEFN \( E_f^o \) per nucleon is given by \( E_f^o / A \). The \( E_f^o / A \) value for \( ^4 \text{He} \), \( ^3 \text{He} \), \( ^3 \text{T} \) and \( ^2 \text{D} \) are 6.1717499, 1.9712373 1.624379, and 0.2101175 MeV/c\(^2 \) respectively, in comparison with their \( E_b / A \) 7.073915, 2.5727, 2.827285, 1.112290 MeV/c\(^2 \) respectively. The \( E_f^o \) values for more than 3200 isotopes have been calculated (visit this link, http://www.mass-energy-e-mbc.com/NMT-files-index.htm, to see the excel files which are monthly updateable). NMT used the SEFN \( E_f^o \) to calculate the energy change \( \Delta E_f^o \) of all nuclear reactions and processes (in similar to enthalpy change of formation \( \Delta H_f^o \) in chemistry). For any nuclear process \( \text{A+B} \rightarrow \text{C+D} \), the energy change for the nuclear reaction can be calculated as follow:

\[
\Delta E_f^o = \sum E_f^o (C + D)_{\text{proc}} - \sum E_f^o (A + B)_{\text{react}} \tag{82}
\]

The positive value of \( \Delta E_f^o \) refers to exoergic nuclear process while the negative value refers to the endoergic process. The \( E_f^o \) values for the fermions (e, p, n) are 0.510998928, 938.278046, and 939.565378 MeV/c\(^2 \) respectively. The nuclides of low latent energy will tend to convert to nuclides of high latent energy to be more stable. This concept is completely different from SMT’s \( \Delta M_A \) and NMT’s \( \Delta M_n \) in two points: first, it uses the standard energy of formation \( E_f^o \) of the nuclides in the calculation rather than the mass defect in SMT or the neutron mass defect in NMT; second, it deducts the reactants from the products unlike SMT and NMT which deducts the products from the reactants. The \( \Delta E_f^o \)-value is based on 194.177 MeV/bc (or 931.5 MeV/c\(^2 \) for purpose of comparison) with consideration of the following points:

a) In negatron decays, we neglect \( M_e \) because one electron leaves and one electron enters, where \( E_{f,mother}^o < E_{f,daughter}^o \).
b) In positron decay, we add $2M_e$ to the right side (products) because one electron and one positron leave, where $E^o_{f,mother} < E^o_{f,daughter}$. The $E^o_f$ of the mother in $\beta^-$ and $\beta^+$ decay is smaller than the $E^o_f$ of the daughter.

c) In EC-decay, the $E^o_f$ of the mother is larger than the daughter which is a sharp criterion for EC-decay, where $E^o_{f,mother} < E^o_{f,daughter}$. In EC decay we add $2M_e$ to the right side (products) to get $Q_{EC}$ value (same as in b). It is different procedure from SMT and NMT due to Eq-82.

d) In any type of nuclear process, the electron will be considered in the total mass as a separate particle if it is needed to conserve the charge as in late fission reactions.

e) In all type of nuclear processes, the mass of the proton and the neutron will not be considered as a separate particle because they are already included in $Z$ and $M_A$.

f) In all type of nuclear processes, (Target nucleus + projectile $\rightarrow$ Final nucleus + ejectile + $Q$) when the neutron is the ejectile or one of the products we will subtract $(M_n-M_H)^*194.177$ plus $2M_e$ i.e. $0.376207$ MeV/bc (or $0.782352 + 2 \times 0.510998928 = 1.80435$ MeV/c$^2$ for purpose of comparison) for each neutron from the total $\Delta E^o_f$ value. If the neutron is the projectile as in $(n,\gamma)$ we have to add $0.376207$ MeV/bc (or $1.80435$ MeV/c$^2$). If there are neutrons on both sides we have to use the net (i.e. $\Delta n=\Sigma n_{product}-\Sigma n_{reactant}$). In nuclear fission reaction we used the compound nuclide i.e. $^{236}U$, $^{239}U$ and $^{240}Pu$ etc. as reactants rather than $n +$ nuclide.

The energy change $\Delta E^o_f$ has been calculated for open and close system. The results of the $\Delta E^o_f$ are identical to that of SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$ for closed systems but they are more comprehensive to cover the open systems. The results of the energy change $\Delta E^o_f$ showed that the EC-decay, $\alpha$-decay, cluster-decay, spontaneous fission, nuclear fusion reaction, and nuclear reactions at accelerators and colliders are close systems. Negatron and positron decays, and nuclear fission reactions in the reactors are open system. The values of $\Delta E^o_f$ are identical with SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$ values for closed system while they are different for open systems as seen in Table-13.

More examples are worked in the Appendix-B. The calculated $Q_T$-value for $^{235}U$ nuclear fissions was in the range 199-212 MeV depending on its fission products and their series of isobars. The $Q_T$-value was better than the Vogt results as seen in Table-13 (see also Table-19 in Appendix-B). The kinetic energy for primary fission for $^{239}Pu$ is higher than that for $^{235}U$. The energy change $\Delta E^o_f$ actually succeeded in calculation of the $Q_T$-values for fission reactions in the reactors (see more explanation in the Appendix-A under Diagram-5).

The energy change $\Delta E^o_f$ succeeded also to explain nuclear decay processes better than SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$, especially when the open system nuclide (take account of mass transfer) was included. For example, the $^{93}Br$ undergoes beta decay with energy $E^\beta_-$ of 11.283 MeV/c$^2$. The calculated $\Delta E^o_f$ is 11.995 MeV/c$^2$ while both SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$, give 10.973 MeV/c$^2$ which is less than the amount of emitted energy. Another example: the $^{139}I$ undergoes beta decay with energy $E^\beta^+_f$ of 7.1174 MeV/c$^2$. The calculated $\Delta E^o_f$ is 7.4498 MeV/c$^2$ while both SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$, give 6.8065 MeV/c$^2$ which is less than the amount of emitted energy.

The energy change $\Delta E^o_f$ values are identical to SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$ values for closed system nuclides, but it gives different values for open system nuclides. The $^{22}Na$ undergoes positron decay with energy $E^\beta_-$ of 2.843 MeV/c$^2$. The calculated $\Delta E^o_f$ is 2.8423 MeV/c$^2$ while both
SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$, give 1.8203 MeV/c² which is less than the amount of emitted energy. The energy change $\Delta E^o_f$ can distinguish between the EC and $\beta^+$ decays because always the $E^o_f$ of the mother larger than the daughter in EC decays while the $\Delta E^o_f$ of the mother is the smaller one in $\beta^+$ decay. If the $\Delta E^o_f$ of the mother smaller than the daughter in EC decays it will not happen.

Table-13: The energy change $\Delta E^o_f$ (in MeV/c²) for some closed and open system. ¹⁸²NBL&IAEA

<table>
<thead>
<tr>
<th>Nuclear Process: Fission-decay Q-value</th>
<th>$\Delta E^o_f$ (MeV/c²)</th>
<th>SMT (MeV/c²)</th>
<th>NMT (MeV/c²)</th>
<th>Type of the System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 $^{252}<em>{98}$Cf $\rightarrow ^{140}</em>{54}$Xe $+ ^{108}_{44}$Ru $+ 4n$.</td>
<td>200.418</td>
<td>200.418</td>
<td>200.418</td>
<td>Closed</td>
</tr>
<tr>
<td>2 $^{235}<em>{92}$U $\rightarrow ^{231}</em>{90}$Th $+ ^{2}_{2}$He.</td>
<td>4.6787</td>
<td>4.6783</td>
<td>4.6783</td>
<td>Closed</td>
</tr>
<tr>
<td>3 $^{10}<em>{5}$B $+ p \rightarrow ^{11}</em>{6}C + (8.6913$ MeV)</td>
<td>8.6894</td>
<td>8.6894</td>
<td>8.6894</td>
<td>Closed</td>
</tr>
<tr>
<td>4 $^{3}\bar{T} + ^{4}<em>{2}$He $+ ^{2}</em>{1}n + (11.3$ MeV)</td>
<td>11.332</td>
<td>11.332</td>
<td>11.332</td>
<td>Closed</td>
</tr>
<tr>
<td>5 $^{223}<em>{88}$Ra $\rightarrow ^{209}</em>{82}Pb + ^{14}_{6}C$.</td>
<td>31.8295</td>
<td>31.8295</td>
<td>31.8295</td>
<td>Closed</td>
</tr>
<tr>
<td>6 $^{22}<em>{11}$Na $\rightarrow ^{22}</em>{10}$Ne $+ e^{-} + \nu_e$ (2.8431², 2.843²)</td>
<td>2.8423</td>
<td>1.8203</td>
<td>1.8203</td>
<td>Open</td>
</tr>
<tr>
<td>7 n $+ ^{235}<em>{92}$U $\rightarrow ^{236}</em>{92}$U $\rightarrow ^{94}<em>{42}$Mo $+ ^{140}</em>{55}$Ce $+ 2n + 8\beta$</td>
<td>203.439</td>
<td>195.677</td>
<td>195.677</td>
<td>Open</td>
</tr>
<tr>
<td>8 n $+ ^{235}<em>{92}$U $\rightarrow ^{236}</em>{92}$U $\rightarrow ^{40}<em>{19}$K $+ e$ $\rightarrow ^{40}</em>{18}$Ar $+ \nu_e$ but the $E^o_f$ value for the mother $^{36}<em>{17}$Cl $\rightarrow ^{36}</em>{16}$S $+ \nu_e$ but the $E^o_f$ value for the mother $^{36}<em>{17}$Cl $+ e$ $\rightarrow ^{36}</em>{16}$S $+ \nu_e$</td>
<td>210.974</td>
<td>205.255</td>
<td>205.255</td>
<td>Open</td>
</tr>
</tbody>
</table>

Based on the energy change $\Delta E^o_f$, the nuclide either undergoes EC or positron decay but it cannot undergo both of them. Both SMT and NMT criteria for EC-decay depend on the mass defect rule which should achieve the condition that $\Delta M_A$ mass defect*931.5 < 1.02 MeV/c² but it is not sharp criteria for some isotopes. For example, both SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$ give 0.120 MeV/c² for $^{36}_{16}$Cl $\beta^+$-decay and 1.142 MeV/c² for $^{36}_{17}$Cl EC-decay $^{36}_{17}$Cl $+ e$ $\rightarrow ^{36}_{16}$S $+ \nu_e$ but the $E^o_f$ value for the mother $^{36}_{16}$Cl (272.509 MeV/c²) is smaller than the daughter $^{36}_{17}$S (272.629 MeV/c²). Therefore, EC-decay will not happen based on SEFN conditions. Also SMT’s $\Delta M_A$ and NMT’s $\Delta M_n$ give 0.483 MeV/c² for $^{40}_{19}$K $\beta^+$-decay and 1.505 MeV/c² for EC-decay $^{40}_{19}$K $+ e$ $\rightarrow ^{40}_{18}$Ar $+ \nu_e$ but the $E^o_f$ value for the mother $^{40}_{19}$K (303.634 MeV/c²) is smaller than the daughter $^{40}_{18}$Ar (304.117 MeV/c²). Therefore, EC-decay will not happen based on SEFN conditions. The $^{11}_{5}$C, $^{54}_{25}$Mn and $^{58}_{28}$Co cannot undergo EC-decay based on SEFN conditions. There are more than 65 examples on different nuclear processes mentioned in the Tables 14-22 in the Appendix-B.

The standard energy of formation of nuclide $E^o_f$ of $^{2}$H, $^{6}$H, $^{7}$H, $^{5}$Be, and $^{6}$B have a negative values -0.535, -3.24, -4.25, -2.58 and -0.898 MeV/c² respectively which means that these element cannot be created.

If we use binding energy $E_B$ values instead of $E^o_f$ in Eq. 82, only the results of closed system are identical to SMT, NMT, and $E^o_f$ results while they give meaningless values for open system especially in fission reactions and decay processes.

5. NMT Independent-Particle Nuclear Model
Although the independent-particle models [i.e. Fermi gas model (semi-classical); and shell model (quantum mechanical), and the collective models; i.e. liquid drop model, rotational and vibrational] afforded answers to some nuclear phenomena, but still there are effects and phenomena needing
answers. NMT proposed an independent-particle nuclear shell model to contribute with these nuclear models in order to assist in the expectation of decay modes and to identify the fertile and fissile nuclide through shell configuration. This NMT model will also help in understanding the reasons beyond the stability of the nuclei odd-odd, even-even and in explaining to magic numbers.

NMT nuclear shell model assumes that the nucleus is a quantum n-body system that can be described by non-relativistic Schrodinger equation. The nucleus is a composite of many spheres occupied by 1-4 nucleons, and these spheres are distributed among hypothetical nuclear shells. The spheres are in stationary states and interact under the nuclear four forces fields. The nucleons interact via a four-body or minimum two-body inside the sphere. This module explains why the heavy nuclides are ready to emit alpha particles. The mother nuclide will emit $\gamma$-ray of discrete line due to excitation after emitting $\alpha$-particle. $\beta$-particles are emitted with a broad continuous energy spectrum because $\beta$-particles created due to the UQM in which the radioisotope emits the extra neutron mass as $\beta$-rays and magnetons.

The spheres in the nuclear shells are formed based on the $2(2)^n$ rule. The shell model gives the mass number, $A$, six levels filled by 4, 8, 16, 32, 64, 128 respectively. The filling process is very systematic. We have to fill each sphere first by proton, then by neutron, and so on, i.e. (pn,pn) until each sphere is filled up with 4 nucleons (xx,xx) where x is the proposed position of the nucleon in the sphere. When there is a lack in neutrons, we continue in filling to put (px,xx), (pp,xx), (pp,px) or (pp,pp). When there is a lack in protons, we continue in filling to put (nx,xx), (nn,xx), (nn,nx) or (nn,nn). The conservons $\kappa$ and the nmtionic bonds between the nucleons will help them to stay in these spheres in stable states. As we explained in previous sections, the proton can pair with the neutron through the nmtionic bonds because the neutron 4th N shell has a negative charge and the proton 3rd M has a positive charge. The two neutrons can change the direction of spinning of the magnetons of the 4th N shells to flip their spins to have paring opposite spin to occupy the sphere in similar way the electrons do in the atomic orbital. This paradigm explains why there are peaks at $A=4n$ in the common $E_b/A$ graph.

If the sphere has two nucleons, we say it is a half-sphere, and if it has four nucleons, we say it is a full-sphere. Both half and full sphere give a stable nuclide if the nuclide has QM$^n$. If QM$^n$ is not achieved then the nuclide will undergo a decay process. The mass quantization concept of the neutron is the main factor which controls the stability. As we stated the he decay process is mass quantized and not random process where the neutron with UQM$^n$ decays until it reaches the QM$^n$.

NMT suggests labels for the nuclear shells to be S1, P2, D3, F4, G5, and H6. Based on the $2(2)^n$ rule, the nuclear shells will have 1, 2, 4, 8, 16, 32 spheres as seen in Figure-25 in Appendix-C. To find the shell configuration, the first step is to divide Z/2 to know the location of last proton (last inner shell). The second step is to divide A/4 to find the last sphere number (last outer shell). For example, for $^{54}_{25}$Mn, where Z=25, A=54, the first step is Z/2=12.5; this means the last proton location is half of sphere number 13, or F4-13(pn,nn). The second step is A/4=13.5; this means the last sphere location is half of sphere number 14, or 14-(nn), thus the final shell configuration is F4-13(pn,nn)-14(nn).

For $^{99}_{45}$Mo where Z=42, A=99, the first step is 42/2= 21. The second step is 99/4=24.75. Thus, the final shell configuration is G5-21(pn,nn)-25(nn,n).

NMT can describe the nuclide shell configuration by writing its outer main shell X (S1, P2, etc.) with number of the last sphere K (K=1, 63, K'=1, 63') (i.e. Isotope-X-K). In addition, the last inner shells which includes the protons. For example, $^4$He has S1-1(pn,nn) configuration (i.e. X=S1, K=1); and $^6$Li has P2-2(pn) configuration (i.e. X=P2, K=2). Sometimes, we need to mention the preceding sphere (K-1) to explain the decay process. For example, $^{22}$Na has the shell configuration D3-5(pn) (i.e. X=D3, K=5), but we have to write this shell configuration as D3-4(pn,nn)+5(pn).
has this H6-40(pn,nn)-44(nn,nn), but we have to write this shell configuration as H6-39(pn,nn)-40(pn,nn)-44(nn,nn).

The QM\textsubscript{n} concept and the shell configurations of He-isotopes (\textsuperscript{3}He-\textsuperscript{10}He) may help to explain the decay mode. For example, \textsuperscript{6}He S1-1(pn,pn)-P2-(nn) has 0.8s which are expected to emit beta to convert to a stable \textsuperscript{6}Li S1-1(pn,pn)-P2-(nn) while \textsuperscript{6}He S1-1(pn,pn)-P2-(nn) has 7.6x10^{-22}s which are expected to emit neutron to reach stable He-4 S1-(pn,nn). In section 3.1, we stated that most of isotopes which are next to the stable nuclide of QM\textsubscript{n} have very short half-lives.

The five stable odd-odd nuclei \( \text{H}^{180m}_{73} \), \( \text{B}^{10}_{5} \), \( \text{Li}^{6}_{3} \), \( \text{N}^{14}_{7} \), \( \text{Ta}^{180}_{73} \) have half-sphere, i.e. X-K(pn) configuration, except \( \text{Ta}^{180}_{73} \) which has X-K(pn,nn) configuration. The even-even nuclei have a half or complete sphere.

NMT nuclear shell model also gives an acceptable explanation for the stability of the magic numbers as follows. For atomic masses A: 2 has \( \frac{1}{2} \) S1 shell, 8 has \( \frac{1}{2} \) P2 shell, 20 has \( \frac{1}{2} \) D3 shell, 28 has full shell, 50 has \( \frac{1}{2} \) (13) of F4 shell, 82 has \( \frac{1}{2} \) (21) of G2 shell and 126 has \( \frac{1}{2} \) (32) of H6 shell. For Z values: 2 has complete S1, 8 has \( \frac{1}{2} \) (4), 20 has complete (10) of F4, 28 has complete (14) of F4, 50 has complete (25) of G5. It is noticed that for heavy nuclide the sphere XH\textsuperscript{6}K-57\textsuperscript{g} gives relatively the most stable nuclide. Reviewing all nuclide with magic number N=50 which are 20 nuclides, NMT found only 5 stable nuclides among them (i.e \textsuperscript{86}Kr, \textsuperscript{87}Rb, \textsuperscript{89}Y, \textsuperscript{90}Zr, \textsuperscript{92}Mo, \textsuperscript{94}Mo) while the other nuclides are radioactive thus questioning this magic number.

The NMT nuclear shell model may explain the reason behind the stability of the following nuclides which achieve both the neutron quantized mass QM\textsubscript{n} and stable configuration.

1. \( \text{He}^{4}_{2} \) has S1-1(pn,pn). It has full-sphere and complete shell with QM\textsubscript{n}. It is very stable.
2. \( \text{Li}^{6}_{3} \) has P2-2(pn). It has half-sphere and incomplete shell due to QM\textsubscript{n}. It is stable.
3. \( \text{B}^{10}_{5} \) has P2-3(pn). It has half-sphere and incomplete shell due to QM\textsubscript{n}. It is stable.
4. \( \text{C}^{12}_{6} \) has P2-3(pn,pn). It has full-sphere and complete shell with QM\textsubscript{n}. It is very stable.
5. \( \text{O}^{16}_{8} \) has D3-4(pn,pn). It has full-sphere and incomplete shell due to QM\textsubscript{n}. It is stable.
6. \( \text{O}^{18}_{8} \) has D3-5(nn) and it is more stable (abundance 0.205\%) than \( \text{O}^{17}_{8} \) which has D3-5(n) (abundance 0.038\%).

Based on this nuclear shell model, NMT elucidates the reason behind the decay process for radioactive nuclide to reach the stable nuclides of QM\textsubscript{n}. All heavy nuclides with odd Z which have X-K(pn,nn) configuration are highly competent to be beta emitters and strong gamma emitters such as \( \text{Na}^{24}_{11} \), \( \text{Co}^{60}_{27} \), \( \text{Cs}^{137}_{53} \), \( \text{La}^{140}_{77} \), \( \text{Ir}^{192}_{77} \), \( \text{Ac}^{228}_{89} \), \( \text{Am}^{241}_{95} \) and others. All heavy nuclides with even Z which have X-K(pn,pn) configuration are highly competent to be alpha emitters. Some light nuclides which luck to protons with X-K(nn,nn) configuration will undergo beta decay. A few light nuclides which luck to neutrons with X-K(pn,pp) or X-K(pn,p) configuration will undergo positron decay as seen in the following examples.

1. \( \text{Li}^{8}_{3} \) has P2-2(pn,nn). This nuclide will undergo this \( \beta^+ \) decay process to achieve the QM\textsubscript{n}. 

\textit{Nuclear Magneton Theory of Mass Quantization "Unified Field Theory"}
\[ ^{6}Li, P2 - 2(pn,nn) \frac{\beta^+}{\text{decay}} \rightarrow ^{4}Be, P2 - 2(pn,pn) \frac{2\alpha}{\text{decay}} \rightarrow ^{2}He \cdot \]

2. has D3-4(pn,nn). This nuclide will undergo this decay process to achieve the QM\(_n\).

\[ ^{16}N, D3 - 4(pn,nn) \frac{\beta^+}{\text{decay}} ^{16}O, D3 - 4(pn,nn) \text{ stable} \cdot \]

3. \(^{12}Be\) has D3-4(pn,nn). This nuclide will undergo this decay process to achieve the QM\(_n\).

\[ ^{12}Be, P2 - 3(nn,nn) \frac{\beta^+}{\text{decay}} \rightarrow ^{12}B, P2 - 3(nn,nn) \frac{\beta^+}{\text{decay}} \rightarrow ^{12}C, P2 - 3(nn,nn) \text{ stable} \cdot \]

4. \(^{7}Be\) has P2-2(nn,p). This nuclide will undergo this decay process to achieve the QM\(_n\).

\[ ^{7}Be, P2 - 2(nn,p) \frac{\text{EC}}{\text{decay}} \rightarrow ^{7}Li, P2 - 2(nn,\text{n}) \text{ stable} \cdot \]

5. \(^{8}Be\) has P2-2(nn,nn). This nuclide will undergo this decay process to achieve the QM\(_n\).

\[ ^{8}Be, P2 - 2(nn,nn) \frac{2\alpha}{\text{decay}} \rightarrow 2^+He \cdot \]

6. \(^{5}B\) has P2-2(nn,pp). This nuclide will undergo this decay process to achieve the QM\(_n\).

\[ ^{5}B \rightarrow P2 - 2(nn,pp) \frac{\beta^+}{\text{decay}} \rightarrow ^{5}Be, P2 - 2(nn,pp) \frac{2\alpha}{\text{decay}} \rightarrow 2^+He \cdot \]

7. \(^{6}C\) has P2-2(nn,pp)+3(p). This nuclide will undergo several decay processes to achieve the QM\(_n\).

\[ ^{6}C \rightarrow P2 - 2(nn,pp)+3(p) \frac{\beta^+}{\text{decay}} \rightarrow ^{5}B, P2 - 2(nn,pp)+3(p) \frac{\beta^+}{\text{decay}} \rightarrow ^{5}Be, P2 - 2(nn,pp) \frac{2\alpha}{\text{decay}} \rightarrow 2^+He \cdot \]

8. \(^{10}N\) has D3-3(nn,nn)-4(p). This nuclide will undergo two decay processes to achieve the QM\(_n\).

\[ ^{10}N \rightarrow P2 - 2(nn,pp)+4(p) \frac{\beta^+}{\text{decay}} \rightarrow ^{9}C \rightarrow P2 - 2(nn,pp)+3(p) \text{ which decays more as above} \cdot \]

9. \(^{11}O\) has D3-3(nn,nn)-4(p). This nuclide will undergo two decay processes to achieve the QM\(_n\).

\[ ^{11}O, P2 - 3(nn,pp)+4(p) \frac{\beta^+}{\text{decay}} \rightarrow ^{10}N, P2 - 3(nn,pp)+4(p) \frac{\beta^+}{\text{decay}} \rightarrow ^{10}C, P2 - 3(nn,pp) \text{ stable} \cdot \]

Although most actinide isotopes with an odd A (odd N and even Z) are fissile, but this NMT nuclear shell configuration gives more clear vision about fissile and fertile. NMT noticed that the fertile, which accepts fast neutron, has either half X(nn) or full sphere X(nn,nn) configuration and that the fissile, which accepts thermal neutron, has either ¼ X(n) or ¾ X(nn,n) configuration as seen in Table-23A and B below. More fertile and fissile are expected in Table-24 in Appendix-C.

**Table-23-A:**  Fertile and fissile identification based on NMT nuclear shell configurations

<table>
<thead>
<tr>
<th>Fissile</th>
<th>(\Delta E_f/CE)</th>
<th>(\sigma_{av} (b))</th>
<th>(\sigma_{af} (b))</th>
<th>Config.</th>
<th>Fertile</th>
<th>(\Delta E_f (n,\gamma))</th>
<th>(\sigma_{av} (b))</th>
<th>(\sigma_{af} (b))</th>
<th>Config.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(^{233}U)</td>
<td>6.845 5.5</td>
<td>45.26</td>
<td>531.3</td>
<td>(59(n))</td>
<td>(^{232}Th)</td>
<td>4.786 5.9</td>
<td>7.338</td>
<td>53.71 (\mu b)</td>
<td>(58(nn,nn))</td>
</tr>
<tr>
<td>(^{235}U)</td>
<td>6.545 5.75</td>
<td>98.71</td>
<td>585.1</td>
<td>(59(nn,nn))</td>
<td>(^{234}U)</td>
<td>5.298 4.6</td>
<td>100.3</td>
<td>67 (mb)</td>
<td>(59(nn))</td>
</tr>
<tr>
<td>(^{233}Pa)</td>
<td>5.22 ***</td>
<td>39.42</td>
<td>2.50 (\mu b)</td>
<td>(59(n)*)</td>
<td>(^{232}U)</td>
<td>5.126 5.3</td>
<td>5.123</td>
<td>0.2594</td>
<td>(59(nn,nn))</td>
</tr>
<tr>
<td>(^{237}Np)</td>
<td>5.488 ****</td>
<td>178.1</td>
<td>20.19 (mb)</td>
<td>(60(n)*)</td>
<td>(^{236}U)</td>
<td>4.806 5.85</td>
<td>2.683</td>
<td>16.8 (\mu b)</td>
<td>(60(nn))</td>
</tr>
<tr>
<td>(^{239}Pu)</td>
<td>6.534 5.5</td>
<td>274.32</td>
<td>699.34</td>
<td>(60(nn,nn))</td>
<td>(^{238}Pu)</td>
<td>5.646 ****</td>
<td>412.8</td>
<td>17.77</td>
<td>(60(nn))</td>
</tr>
<tr>
<td>(^{241}Pu)</td>
<td>6.310 ***</td>
<td>334.11</td>
<td>936.65</td>
<td>(60(n))</td>
<td>(^{240}Pu)</td>
<td>5.242 4.0</td>
<td>289.3</td>
<td>36.21 (mb)</td>
<td>(60(nn,nn))</td>
</tr>
</tbody>
</table>
6. Black Hole Density and Dark Matter

In the core of the sun and stars, where the packages of magnetons are used to create the quantized fermions (e,n,p) to form the different nuclei, an enormous number of these packages of magnetons failed to attach themselves to the quantized packages of fermions. Therefore, these fragments of packages of magnetons changed into different agglomerates to fill the universe as dark matter as they are neither capable of absorbing nor of radiating energy.

Another parallel crashing process happens to the nuclei, during fusion reactions, due to the severe conditions of high temperatures. The OCEM shell of the nuclei becomes loose, setting free the protons and neutrons to undergo the fusion reactions in a state of equilibrium to generate all types of elements. This phase, where the outer charged electromagnetic shell OCEM shell is torn and the nucleons are free, is called “Nuclear Transparency” which represents a fifth state of matter beyond plasma. When these free nucleons experience further vehement conditions, they will be crashed into unquantized masses and gigantic packages of these magnetons fly out of the stars into the universe as dark matter.

These different agglomerates of magnetons will be collected again to form kernels and will accumulate in groups, moving between the gases of the stars appearing as black spots or sunspots, see our article in 2008\textsuperscript{[43]}. NMT called these kernels “Nuclear Magma” and this state of matter may be called the sixth state of matter. As long as these agglomerates of magneton kernels form in an arbitrary manner, they will build up amorphous massive kernels that cannot absorb or emit radiation. Therefore, the spots appear as dark spots and are relatively colder than the other areas with high magnetic field due to the magneton’s magnetic property\textsuperscript{40}. These sunspots collect together through millions of years to form a black hole state. The high density of the magnetons of $2.583969548\times10^{66}$ kg/m$^3$ in the Nuclear Magma gives the black holes the giant dense mass which attracts any mass falling under its gravitational field. Due to black hole’s magnetic property, it will also interfere with the magnetic fields.

\textsuperscript{40} NOAA report in 22 February 2013 states that “Sunspots are temporary phenomena on the photosphere of the Sun that appear visibly as dark spots compared to surrounding regions. They are caused by intense magnetic activity, which inhibits convection by an effect comparable to the eddy current brake, forming areas of reduced surface temperature. They usually appear as pairs, with each sunspot having the opposite magnetic pole than the other.” See also NASA reports.
of waves such as light which come near the black hole. Moreover, NMT believes that this gravitational field is accompanied by a magnetic field due to the magnetic properties. Both generate the gravitomagnetic field which results from the action of the mass gradient vector and the magnetic field vector.

7. Conclusion
The proposed nuclear theory of magnetons as the constituents of the sub-nuclear structure carries with it the implication that the original mass in the universe was built from two basic units: the magneton and the antimagnet. The NMT confirms that the mass in the universe is quantized and is composed of a package of elementary discrete mass particles called magnetons.

The magneton and antimagnet were compacted under severe circumstances in stellar cores. These two magnetons form the assemblage or package of quantized mass which is accumulates to form fermions. The magnetons behave like rotating spinning magnetic bars inside the fermions, which in turn creates a Strong Charged Electromagnetic Force (SCEF) field of long range with characteristic strong magnetic constant and self-gravity force, (SGF) (gravitational force). This SGF acts in ultrashort range inside the fermions all of which constitutes the strong Self-Nuclear Force (SSNF) (i.e. an integrated gravitomagnetic field and electromagnetic field). Some of this energy will be used as nuclear force inside the nucleon (fermion) and the other part of the energy will be used as binding energy among the nucleons inside the nucleus with help from *conservons*. This SSNF is responsible for all types of nuclear forces as they are of the same field. It is stronger inside the nucleon than among protons and neutrons. The SSNF field represents the strong nuclear forces, weak nuclear forces, electromagnetic forces, and gravitational forces. Therefore, it is considered as a force of [Unified Field](#).

The stability of the particle and antiparticle has been discussed from four criteria points of view which are based on the concept of this NMT theory.

When electrons interact with positrons, they will form positronium atoms of unquantized mass. These magnetons of this positronium atom will disintegrate into discrete magnetons, in similar manner to proton-antiproton decay, and the magneton’s packages energy will be released and recorded as 1.022 MeV/c². Therefore, there is no *annihilation* reaction as the scientific community believes, but it is a *disintegration* process.

The proton has a certain number of magnetons so it has one quantized mass while the neutron has several quantized masses. The number of magnetons in a neutron is variable, depending on the number of the protons in that nuclide; therefore it has several quantized masses. The special and characteristic property of neutrons to have several quantized masses inside the nuclides is responsible for the existence of isotopes, their decay and all type of nuclear reactions.

In the outline of this theory, the NMT suggests that both the electron and the proton textures have three quantized nmtionic shells: 1ˢᵗ K, 2ⁿᵈ L, and 3ʳᵈ M while the neutron texture has four quantized nmtionic shells: 1ˢᵗ K, 2ⁿᵈ L, 3ʳᵈ M, and 4ᵗʰ N. The nmtionic shells concept will set up a new foundation to the quantum field theory. This shell concept succeeds in explaining many nuclear properties such as magnetic moment of the proton and the neutron.

Based on neutron mass defect ΔMₙ rather than the mass defect ΔMₐ and mass conversion, this Nuclear Magneton Theory (NMT) succeeds in the calculation of the binding energies and the Q-values of all types of decays and nuclear reactions in reactors, accelerators, colliders. The results of these calculations are with full agreement with experimental data and SMT theory calculations. The energy change ΔEᵣ, based on the standard energy of formation of nuclide Eᵣ, succeeds in explaining nuclear reactions and decay processes better than SMT’s ΔMₐ or NMT’s ΔMₙ especially for the open system nuclide. The results of the energy change ΔEᵣ calculations showed that the EC, α, and cluster-decay, spontaneous fission, nuclear fusion reaction, and nuclear reactions at accelerators and colliders are close systems. The nuclear fission reactions in the reactors, β⁻ and β⁺ decays are open system. This theory also succeeded in prediction of decay energies, the half-life, radioactivity, atomic masses of the isotopes, and identification of the fissile and the fissionable nuclide. The neutron mass defect ΔMₙ which based on mass quantization, the Mass-Energy Conformity Principle, standard energy of
formation of nuclide $E_o$ and energy change $\Delta E_o$ are new concepts in nuclear science and considered as the main premise of NMT which used in the nuclear calculations.

Acknowledgement
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References


[48] [http://www.physik.uni-mainz.de/exakt/neutrino/en_experiment.html](http://www.physik.uni-mainz.de/exakt/neutrino/en_experiment.html), the electron neutrino mass of \( m < 2.2 \text{ eV}/c^2 \) (95% Confidence Level) "The Mainz Neutrino Mass Experiment"


The behavior of $E_b/A$ versus QM$_n$ is similar to that $E_b/A$ versus atomic number A as seen in Diagram-5A. The QM$_n$ values which ranges between 0.991-0.9925 u give the highest $E_b/A$. The fission products have an average QM$_n$ at 0.99374 u while the excited fissionable $^{236}$U has 0.99532712 and the difference (i.e. 0.00158712 u) will give an average 207.14 MeV/c$^2$ per fission with 2n free and 205.14 MeV/c$^2$ with 3n free. This fact also confirms the neutron mass quantization. The symmetrical fission will give higher kinetic energy for the primary fission as the average UQM$_n$ is 0.99393312 u and the mass difference is 0.00138380 u which gives 181.75 MeV/c$^2$ per fission with 2n free and 180.5 MeV/c$^2$ with 3n free rather than average 178 MeV/c$^2$ with 2n free and average 169 MeV/c$^2$ with 3n free for unsymmetrical primary fission. All these results are in good agreement with experimental and theoretical data of the nuclear reactors (See Table-20).

The QM$_n$ and UQM$_n$ for more than 3200 isotopes have been calculated. Plotting QM$_n$ vs. Z and N as seen in Diagram-5B&C showed that the most stable atomic numbers are Z=2, 8, 20, 28, 49, 61, 75, 84 and 107 and the most stable neutron numbers are N= 2, 8, 20, 30, 34, 38, 50, 64, 84, 110 and 126 which are near to magic numbers of the nuclear shell model. These numbers are very close to 3D harmonic oscillator values which are 2, 8, 20, 40, 70, 112 etc. If we add the spin-orbit interaction, we get the magic number 2, 8, 20, 28, 50, 82, 126, 184, etc. The QM$_n$ vs. Z give a stable Z=107 which is not equal to expected number Z=114.

**Diagram-5A:** Binding energy/A as a function of QM$_n$ in the stable isotopes
Re-3.3. Isobars Energies Prediction from Mass Quantization Principle

In this appendix we show how one can calculate the $\Delta m$ in UQM$_m$ for the isobars. Table-2&3 is an example.

**Table-2:** Nuclear data for I-139 isobars. *These data are from JAEA*

<table>
<thead>
<tr>
<th>Isobars</th>
<th>$\beta$* Energies (KeV)</th>
<th>$M_A$* (u)</th>
<th>$N_{Mz}=M_A-ZM_H$ (u)</th>
<th>Mass of Neutron (u)</th>
<th>$UQM_m$</th>
<th>$\Delta m$ in UQM$_m$ (u)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-139</td>
<td>6806</td>
<td>138.92609947</td>
<td>85.51137278</td>
<td>1.0179925393333</td>
<td>0.0008996730042</td>
<td>0.00002448621863</td>
</tr>
<tr>
<td>Xe-139</td>
<td>5057</td>
<td>138.91879293</td>
<td>84.49624120</td>
<td>0.9940734259764</td>
<td>0.0006541801879</td>
<td>0.00002283397979</td>
</tr>
<tr>
<td>Cs-139</td>
<td>4212</td>
<td>138.91336399</td>
<td>83.48298723</td>
<td>0.9938450861785</td>
<td>0.0004264710200</td>
<td>0.00002229229376</td>
</tr>
<tr>
<td>Ba-139</td>
<td>2317</td>
<td>138.90884134</td>
<td>82.47063954</td>
<td>0.9936221632409</td>
<td>0.0002035480824</td>
<td>0.00002035480824</td>
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<tr>
<td>La-139</td>
<td>stable</td>
<td>138.90635326</td>
<td>81.46032644</td>
<td>0.9934181651585</td>
<td>0.0000000000000</td>
<td>0.0000000000000</td>
</tr>
</tbody>
</table>

**Table-3:** Nuclear data for isobars. *These data are from JAEA.*

<table>
<thead>
<tr>
<th>Figures</th>
<th>Isobars</th>
<th>$\beta$* Energies (KeV)</th>
<th>Binding Energy (KeV)</th>
<th>$t_{u2}$ sec</th>
<th>$\Delta m$ in UQM$_m$</th>
<th>$1/\Delta m$ increment</th>
<th>$E_m/\Delta m$</th>
<th>$L_m (E_m/\Delta m)$</th>
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<tbody>
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<td>Figure-3</td>
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<td>8347</td>
<td>8456.834</td>
<td>1.86</td>
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<td>0.00121128249999</td>
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<td>8456.834</td>
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<td>1.86</td>
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<td>1244</td>
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<td>6.09892785</td>
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<td>2.49</td>
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<tr>
<td>Figure-5</td>
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<td>4913.93110</td>
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<td>Stable</td>
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<td>Figure-6</td>
<td>4360</td>
<td>7968.2836</td>
<td></td>
<td>10.56</td>
<td>2.357073</td>
<td>0.0001819789761</td>
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<td>2730</td>
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<td>7968.2836</td>
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<td>10.56</td>
<td>2.357073</td>
<td>0.0001819789761</td>
<td>5495.14</td>
<td>4378683.6</td>
</tr>
</tbody>
</table>

*These data are from JAEA.*
The $\beta$-energies of isobars series of $^{139}I$ and $^{157}Pm$ versus the $\Delta m$ in UQM$_n$ shows a high linearity to confirm the mass quantization. Such correlations help in the prediction of the very short half-lives of any isobar. Tables-1 and 2 are considered as a sample for any isobar calculation.

$$139I: 2.285s \quad 139Xe: 39.68s \quad 139Cs: 9.27m \quad 139Ba: 85.06m \quad 139La.$$

$$157Pm: 10.65s \quad 157Sm: 482s \quad 157Eu: 15.18h \quad 157Gd.$$

The plot of $\beta$-energies versus ($E_b/\Delta m$) factor for these isobars shows a negligible effect on the linearity which confirms that the $\beta$-energies of isobars are mainly affected by UQM$_n$ factor.

**Re-3.4. Half-life Prediction of Isobars from Mass Quantization Principle**

Figure-9 showed that the $^{139}Cs$ has an irregular half-life value. Plotting logarithms of the half-lives of $^{139}Ba$, $^{139}Xe$, and $^{139}I$ versus their ($E_b/\Delta m$) (Fig-11) and (1/\(\Delta m\)) in UQM$_n$ (Fig-12) gives the $\ln(t_{1/2}) = 1E^{-06} (E_b/\Delta m) - 31.847$, $R^2 = 0.9988$ and $\ln(t_{1/2}) = 0.0086 (1/\Delta m) - 33.991$, $R^2 = 0.9988$ respectively which predicts the half-life of $^{139}Cs$ to be $t_{1/2} = 264$ s and $98$ s respectively as seen in Figures-11&12. This is to confirm that the half-life is affected by the binding energies of its nuclide. Therefore, we adopted $t_{1/2} = 264$ s for $^{139}Cs$ rather than the literature value 556 s (9.27m).

**Figure-9:** $\ln(t_{1/2})$ versus $\ln(E_b/\Delta m$ in UQM$_n$) for isobar $^{139}I$ where $^{139}Cs$ has abnormal $\ln(t_{1/2})$

**Figure-10:** $\ln(t_{1/2})$ versus ($E_b/\Delta m$ in UQM$_n$) for isobar $^{157}Pm$
Figure-11: \( \text{Ln}(t_{1/2}) \) versus \( (E_b/\Delta m \text{ in UQM}_n) \) for isobar \(^{139}\text{I}\) series \((^{139}\text{I}, ^{139}\text{Xe} \text{ and } ^{139}\text{Ba})\) to find \( t_{1/2} \) for \(^{139}\text{Cs}\). This formula gives 264 s for \(^{139}\text{Cs}\).

Figure-12: \( \text{Ln}(t_{1/2}) \) versus \( (1/\Delta m \text{ in UQM}_n) \) for isobar \(^{139}\text{I}\) series \((^{139}\text{I}, ^{139}\text{Xe} \text{ and } ^{139}\text{Ba})\) to find \( t_{1/2} \) for \(^{139}\text{Cs}\). This formula gives 98 s for \(^{139}\text{Cs}\).

Re-3.5. Half-life Prediction of Isotopes from Mass Quantization Principle

Table-4: Gallium Isotopes and their half-life

<table>
<thead>
<tr>
<th>Isotope</th>
<th>( t_{1/2} )</th>
<th>( t_{1/2} \text{ sec} )</th>
<th>( M_A )</th>
<th>( M_A - Z \text{M}_H )</th>
<th>Mass of neutron, ( M_n )</th>
<th>Neutron unquantized mass increments, ( \Delta \text{UQM}_n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ga-69</td>
<td>(61.1%)</td>
<td>stable</td>
<td>68.926550281</td>
<td>37.683974289</td>
<td>0.991683533921053</td>
<td>0.000000000000000</td>
</tr>
<tr>
<td>Ga-72</td>
<td>14.10h</td>
<td>50760</td>
<td>71.926366268</td>
<td>40.683790276</td>
<td>0.992287567707317</td>
<td>0.00060433786264</td>
</tr>
<tr>
<td>Ga-73</td>
<td>4.87h</td>
<td>17532</td>
<td>72.925174682</td>
<td>41.68259869</td>
<td>0.9927659762093023</td>
<td>0.000976228179179</td>
</tr>
<tr>
<td>Ga-74</td>
<td>8.1m</td>
<td>486</td>
<td>73.9267945762</td>
<td>42.68436977</td>
<td>0.992816460318182</td>
<td>0.001132926397129</td>
</tr>
<tr>
<td>Ga-75</td>
<td>2.1m</td>
<td>126</td>
<td>74.926500246</td>
<td>43.683924254</td>
<td>0.993027814088889</td>
<td>0.001344280167836</td>
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<tr>
<td>Ga-76</td>
<td>27.1s</td>
<td>27.1</td>
<td>75.928827626</td>
<td>44.686251634</td>
<td>0.993186484956522</td>
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<tr>
<td>Ga-77</td>
<td>13s</td>
<td>13</td>
<td>76.929154300</td>
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<td>0.993386363574468</td>
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<tr>
<td>Ga-78</td>
<td>5.1s</td>
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<tr>
<td>Ga-79</td>
<td>3.0s</td>
<td>3.0</td>
<td>78.932893260</td>
<td>47.690317268</td>
<td>0.993753873244898</td>
<td>0.002070339323845</td>
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<tr>
<td>Ga-80</td>
<td>1.66s</td>
<td>1.66</td>
<td>79.936515781</td>
<td>48.693939789</td>
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<td>0.00221999338947</td>
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<tr>
<td>Ga-81</td>
<td>1.2s</td>
<td>1.2</td>
<td>80.937752355</td>
<td>49.695176363</td>
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<td>0.002442230941692</td>
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<tr>
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<td>0.6s</td>
<td>0.6</td>
<td>81.942990</td>
<td>50.700414008</td>
<td>0.994315461692308</td>
<td>0.002631927771255</td>
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<tr>
<td>Ga-83</td>
<td>0.31s</td>
<td>0.31</td>
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<td>51.704404008</td>
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<td>0.002631927771255</td>
</tr>
</tbody>
</table>

Figure-15: \( \text{Ln}(t_{1/2}) \) versus \( \text{Ln}(E_b/\text{UQM}_n) \) calculated from three isotopes \(^{20}\text{O}, ^{21}\text{O} \text{ and } ^{22}\text{O}\).

Figure-16: \( \text{Ln}(t_{1/2}) \) versus \( \text{Ln}(E_b/\Delta \text{UQM}_n) \) calculated from five isotopes \(^{24}\text{Na} - ^{28}\text{Na}\).
Nuclear Magneton Theory of Mass Quantization "Unified Field Theory"

Figure-17: $\ln t_{1/2}$ versus $\ln(E_b/\Delta UQM_n)$ calculated from two isotopes $^{70}$As and $^{73}$As.

Figure-18: $\ln t_{1/2}$ versus $\ln(E_b/\Delta UQM_n)$ calculated from five isotopes $^{181}$Ir-$^{185}$Ir.

Table-5: Gallium Isotopes, their half-life and binding energies

<table>
<thead>
<tr>
<th>Isotope</th>
<th>$t_{1/2}$</th>
<th>$t_{1/2}$ sec</th>
<th>$\ln t_{1/2}$</th>
<th>$\Delta UQM_n$</th>
<th>$I/\Delta UQM_n$</th>
<th>$E_b/A$</th>
<th>$E_b/\Delta UQM_n$</th>
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<tr>
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<tr>
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<td>17532</td>
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<td>8.660808</td>
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<td>1024.350688</td>
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<td>126</td>
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Table-7: $\ln(E_b/\Delta m UQM_n)$ and Half-life for Oxygen, Sodium, Arsenic and Iridium

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<th>$\ln(E_b/\Delta m UQM_n)$</th>
<th>Half-life (sec)</th>
<th>$\ln(E_b/\Delta m UQM_n)$</th>
<th>Half-life (sec)</th>
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<td>Oxygen</td>
<td>2.25</td>
<td>Arsenic</td>
<td>15.78413</td>
</tr>
<tr>
<td>7.356655973</td>
<td>3.42</td>
<td>15.9763</td>
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</tr>
<tr>
<td>7.446590804</td>
<td>13.51</td>
<td>16.12701</td>
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</tr>
<tr>
<td>7.655542494</td>
<td></td>
<td>17.04495</td>
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<tr>
<td>Sodium</td>
<td>0.0305</td>
<td>Iridium</td>
<td>16.44116620</td>
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<tr>
<td>14.80490952</td>
<td>0.301</td>
<td>16.55898922</td>
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<tr>
<td>15.06731233</td>
<td>1.077</td>
<td>16.65482535</td>
<td></td>
</tr>
<tr>
<td>15.30991369</td>
<td>59.1</td>
<td>16.80152664</td>
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<tr>
<td>15.75939194</td>
<td>897.5</td>
<td>16.93197361</td>
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</tr>
<tr>
<td>16.24653979</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Half-life (sec)</th>
<th>Half-life (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>300</td>
</tr>
<tr>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>3180</td>
<td>3240</td>
</tr>
<tr>
<td>10800</td>
<td>50400</td>
</tr>
</tbody>
</table>
The predicted atomic mass of $^{264}\text{Rf}$ isotope is 264.13775227161 u. Plotting $\text{UQM}_n$ versus mass number A for rutherfordium isotopes gives the following correlation:

$$\text{UQM}_n = 0.0102 \ln(A) + 0.9389 \quad R^2 = 0.9985.$$ 

The figure is not presented in this article.

The predicted atomic mass of Ds isotopes, Ds-268, 274-278, are 268.132637768323 u, 274.140573020287 u, 275.142072392627 u, 276.143621656049 u, 277.145220578326 u, and 278.14686892928 u (These isotopes do not exist). Plotting $\text{UQM}_n$ versus mass number A for darmstadtium isotopes gives the following correlation:

$$\text{UQM}_n = 0.0078 \ln(A) + 0.9406 \quad R^2 = 0.9986.$$ 

The figure is not presented in this article.

The atomic mass evaluation of IAEA and the JAEA did not mention this isotope. Any Isotope can be estimated from the $\text{UQM}_n$-Atomic mass relationship.

### Table-8: Neutron mass and mass number for some isotopes

<table>
<thead>
<tr>
<th>Neutron mass</th>
<th>Mass Number A</th>
<th>Neutron mass</th>
<th>Mass Number A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helium</strong></td>
<td></td>
<td><strong>Polonium</strong></td>
<td></td>
</tr>
<tr>
<td>0.993476595075000</td>
<td>4</td>
<td>0.994452288574754</td>
<td>206</td>
</tr>
<tr>
<td>0.998856645333333</td>
<td>5</td>
<td>0.99457927621935</td>
<td>208</td>
</tr>
<tr>
<td>1.000809759000000</td>
<td>6</td>
<td>0.9946012180960</td>
<td>209</td>
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<td>1.002474187200000</td>
<td>7</td>
<td>0.99464738984127</td>
<td>210</td>
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<tr>
<td><strong>Carbon</strong></td>
<td></td>
<td><strong>Uranium</strong></td>
<td></td>
</tr>
<tr>
<td>0.994695124873333</td>
<td>A</td>
<td>0.994777854000000</td>
<td>212</td>
</tr>
<tr>
<td>0.992475759155000</td>
<td>9</td>
<td>0.994849258232558</td>
<td>213</td>
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<td>0.992986683524000</td>
<td>10</td>
<td>0.994906913169231</td>
<td>214</td>
</tr>
<tr>
<td>0.992174967770000</td>
<td>11</td>
<td>0.994977994748091</td>
<td>215</td>
</tr>
<tr>
<td>0.993772091670000</td>
<td>12</td>
<td>0.995034941757576</td>
<td>216</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td><strong>Americium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.995961006957778</td>
<td>14</td>
<td>0.995218656028169</td>
<td>234</td>
</tr>
<tr>
<td>0.996775105862000</td>
<td>15</td>
<td>0.995272915776224</td>
<td>235</td>
</tr>
<tr>
<td>0.997784440329091</td>
<td>16</td>
<td>0.995317118444444</td>
<td>236</td>
</tr>
<tr>
<td>0.998316840135000</td>
<td>17</td>
<td>0.99537122455173</td>
<td>237</td>
</tr>
<tr>
<td>0.999065211201539</td>
<td>18</td>
<td>0.995417022301370</td>
<td>238</td>
</tr>
<tr>
<td>0.999526397187143</td>
<td>19</td>
<td>0.995472043238095</td>
<td>239</td>
</tr>
<tr>
<td>0.991968414923782</td>
<td>20</td>
<td>0.995518169297297</td>
<td>240</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td><strong>Americium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.993166709275000</td>
<td>15</td>
<td>0.995165048624285</td>
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</tr>
<tr>
<td>0.994591830666666</td>
<td>16</td>
<td>0.995205878148263</td>
<td>239</td>
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<tr>
<td>0.995367477600000</td>
<td>17</td>
<td>0.995254634161034</td>
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</tr>
<tr>
<td>0.996300343272727</td>
<td>18</td>
<td>0.995297609954452</td>
<td>241</td>
</tr>
<tr>
<td>0.996854813333333</td>
<td>19</td>
<td>0.995348103084013</td>
<td>242</td>
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<tr>
<td>0.997584213538461</td>
<td>20</td>
<td>0.995391912522635</td>
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Re-3.7. The Radioactivity of the Isobar and Isotope from the Mass Quantization

A- Isobar Radioactivity: Here are more examples on isobar radioactivity ($\beta^-$ emitters)

Table-10: The calculated radioactivity for some $\beta^-$ emitter isobars

<table>
<thead>
<tr>
<th>Isobars</th>
<th>$A = N/M_A$</th>
<th>$A = N/M_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>3.2551785 E+12</td>
<td>1.1251637E+12</td>
</tr>
<tr>
<td>I-137</td>
<td>1.2436111E+20</td>
<td>5.1518222E+19</td>
</tr>
<tr>
<td>Eu-157</td>
<td>4.8651619E+16</td>
<td>4.6181551E+16</td>
</tr>
<tr>
<td>Sm-157</td>
<td>5.5160035E+18</td>
<td>1.2389525E+19</td>
</tr>
<tr>
<td>Pm-157</td>
<td>2.5177213E+20</td>
<td>2.1522109E+20</td>
</tr>
<tr>
<td>Ba-139</td>
<td>6.0252960E+17</td>
<td>2.6864152E+18</td>
</tr>
<tr>
<td>Cs-139</td>
<td>1.1375210E+19</td>
<td>1.8869485E+19</td>
</tr>
</tbody>
</table>

B- Isotope Radioactivity: Here are 90 examples on isotope radioactivity ($\beta^+/\beta^-$ - emitters)

Table-11: The calculated radioactivity for some $\beta^+/\beta^-$ - emitter’s isotopes

<table>
<thead>
<tr>
<th>Isotopes</th>
<th>$A = N/M_A$</th>
<th>$A = N/M_A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-3</td>
<td>3.6117093E+14</td>
<td>4.4721526E+12</td>
</tr>
<tr>
<td>Li-8</td>
<td>6.1920544E+22</td>
<td>5.0935917E+23</td>
</tr>
<tr>
<td>Be-10</td>
<td>2.6448316E+24</td>
<td>6.2931645E+24</td>
</tr>
<tr>
<td>N-17</td>
<td>5.8811878E+21</td>
<td>1.2913697E+22</td>
</tr>
<tr>
<td>F-21</td>
<td>4.7805233E+21</td>
<td>1.3852416E+22</td>
</tr>
<tr>
<td>Na-25</td>
<td>2.8263454E+20</td>
<td>6.1237343E+20</td>
</tr>
<tr>
<td>Al-29</td>
<td>3.6594686E+19</td>
<td>8.4780457E+19</td>
</tr>
<tr>
<td>P-35</td>
<td>2.5233660E+20</td>
<td>2.9793385E+20</td>
</tr>
<tr>
<td>CI-41</td>
<td>2.6523231E+20</td>
<td>2.9428351E+20</td>
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<td>K-42</td>
<td>2.2356414E+17</td>
<td>3.6746353E+17</td>
</tr>
<tr>
<td>Sc-47</td>
<td>3.0722640E+16</td>
<td>1.7030964E+16</td>
</tr>
<tr>
<td>V-53</td>
<td>8.3498886E+19</td>
<td>3.8235407E+18</td>
</tr>
<tr>
<td>Mn-60</td>
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<td>3.2024245E+20</td>
</tr>
<tr>
<td>Co-62</td>
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<td>2.1069296E+20</td>
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<tr>
<td>Cu-67</td>
<td>2.8020142E+16</td>
<td>1.0387323E+16</td>
</tr>
<tr>
<td>Ga-77</td>
<td>4.1106763E+20</td>
<td>4.4055785E+20</td>
</tr>
<tr>
<td>As-71</td>
<td>2.5042812E+16</td>
<td>7.4438114E+16</td>
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<tr>
<td>Br-84</td>
<td>2.6070691E+18</td>
<td>1.1986421E+19</td>
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<tr>
<td>Rb-80</td>
<td>1.5637320E+20</td>
<td>1.7851505E+20</td>
</tr>
<tr>
<td>Y-94</td>
<td>3.9615857E+18</td>
<td>7.0501528E+18</td>
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<tr>
<td>Nb-97</td>
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<td>9.8479009E+17</td>
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<tr>
<td>Tc-99</td>
<td>1.9538925E+17</td>
<td>2.2196565E+17</td>
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<td>Rh-106</td>
<td>3.1226230E+20</td>
<td>3.3970407E+20</td>
</tr>
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<td>Ag-112</td>
<td>3.3103511E+17</td>
<td>9.8102064E+17</td>
</tr>
<tr>
<td>In-119</td>
<td>2.4277651E+19</td>
<td>2.2627257E+19</td>
</tr>
<tr>
<td>Sn-130</td>
<td>1.3557568E+18</td>
<td>2.0269588E+18</td>
</tr>
<tr>
<td>I-132</td>
<td>3.8300325E+17</td>
<td>6.8000237E+17</td>
</tr>
<tr>
<td>Cs-139</td>
<td>5.4020642E+18</td>
<td>8.9585163E+18</td>
</tr>
<tr>
<td>La-143</td>
<td>3.4281320E+18</td>
<td>6.3531778E+18</td>
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<td>Pr-146</td>
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<td>3.7784946E+18</td>
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<tr>
<td>Pm-150</td>
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<td>4.8568710E+17</td>
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<td>Tb-163</td>
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<td>2.6949908E+18</td>
</tr>
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<td>Ho-167</td>
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<tr>
<td>Tm-173</td>
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<td>7.6298296E+16</td>
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<td>Ta-183</td>
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<td>Re-189</td>
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</tr>
<tr>
<td>Ir-182</td>
<td>2.5489676E+18</td>
<td>3.2525980E+18</td>
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<tr>
<td>Au-199</td>
<td>7.7337010E+15</td>
<td>5.2957878E+15</td>
</tr>
<tr>
<td>Ti-209</td>
<td>1.5403483E+19</td>
<td>3.4448363E+19</td>
</tr>
<tr>
<td>Bi-214</td>
<td>2.7397368E+16</td>
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<td>1.4409358E+15</td>
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<tr>
<td>Pa-232</td>
<td>1.5839989E+16</td>
<td>6.8595218E+16</td>
</tr>
</tbody>
</table>

Nuclear Magneton Theory of Mass Quantization "Unified Field Theory" 127
Appendix-B

The energy of the nuclear decays and reactions are based on neutron mass defect $\Delta M_n$. The value of $\Delta M_n$ is calculated from the difference between the total mass of neutron in left and right side of the equation. The total mass of the neutron in the nuclide is given by $M_A-ZM_H$, where $M_A=$ the spectroscopic measured mass of the nuclide and $ZM_H$ represents the total mass of proton + electron. The value of $\Delta M_n$ will be released as gamma rays.

Re-4.1. Q-value of Nuclear Decay

I. $\beta^-$-decay Q-value

The general formula of $\Delta M_n$ for $\beta^-$-decay is given by:

$$\Delta M_n = [(M_A-ZM_H)_M - (M_A-ZM_H)_D], Z_I = (Z-1)$$

Example-1: $^{137}\text{Cs} \rightarrow ^{157}\text{Ba} + e^- + \bar{\nu}_e$ (1.17563 MeV, from literature)

In any process that includes beta decay, we have to add the mass of proton and electron to right side because one of the neutrons converted into proton and electron.

$^{137}\text{Cs}$ This nuclide has a mass of 136.907089473 u, and it has 55 protons and 82 neutrons.

$^{157}\text{Ba}$ This nuclide has a mass of 136.905827384 u, and it has 56 protons and 81 neutrons.

The net weight of neutrons’ mass inside this nuclide is calculated like this: (136.907089473 - 55 $M_H$) or (136.905827384 - 56 $M_H$) = 136.907089473 - 55.4303767639 = 81.47671270915 u.

$^{137}\text{Cs}$ neutron mass defect is $0.0012621$ u.

The Q-value is 1.175646 MeV/c^2 or 0.2451 MeV/bc. SMT value is 1.175646 MeV/c^2.

Example-2: $^{32}\text{P} \rightarrow ^{32}\text{S} + e^- + \bar{\nu}_e$ (E= 1.715 MeV/c^2, from literature)

$^{32}\text{P}$ This nuclide has a mass of 33.973762819 u, and it has 17 protons and 17 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this: (33.973762819 - 17 $M_H$) or (33.973762819 - 16 $M_H$) = 33.973762819 - 35.1428197772 = -1.1690569583 u.

The Q-value is 1.71049 MeV/c^2 or 0.35656 MeV/bc. SMT value is 1.175646 MeV/c^2.

II. $\beta^+$-decay Q-value

The general formula of $\Delta M_n$ for $\beta^+$-decay is given by:

$$\Delta M_n = [(M_A-ZM_H)_M - (M_A-ZM_H)_D + 2M_e], Z_I = (Z-1)$$

Example-1: $^{34}\text{Cl} \rightarrow ^{34}\text{S} + e^+ + \nu_e$ (Total= 4.4685 MeV/c^2, from literature)

$^{34}\text{Cl}$ This nuclide has a mass of 33.973762819 u, and it has 17 protons and 17 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this: (33.973762819 - 17 $M_H$) or (33.973762819 - 16 $M_H$) = 33.973762819 - 35.1428197772 = -1.1690569583 u.
34

This nuclide has a mass of 33.967866902 u, and it has 16 protons and 18 neutrons. The net weight of neutrons' mass inside this nuclide is calculated like this (33.967866902 – 16 M_H) or (33.967866902 – 16 x 1.00782503207) = (33.967866902 - 16.12520051312) = 17.84266638888 u.

\[ \Delta M_n = [\text{Neutron Mass of Cl (including 1M_H)} - (\text{Neutron Mass of S + 2M_e})] \]
\[ \Delta M_n = [17.84856230588 - (17.84266638888 + 2x0.0005485799095)] \]
\[ \Delta M_n = 0.00479835181 u \]

\[ \Delta M_n \text{ in neutron mass on both sides is 0.004798352 u. The Q-value is 4.46967 MeV/c}^2 \text{ or 0.93173 MeV/bc. SMT value is 4.4697 MeV/c}^2. \]

**Example-2:**

\[ ^{95}Tc \to ^{95}Mo + e^+ + v_e \text{ 20.0 h (Total 1.8395 MeV/c}^2, \text{ from literature)} \]

\[ \Delta M_n \text{ in neutron mass on both sides is 0.002363535 u. The Q-value 2.2016 MeV (based on 931.5 MeV/c}^2 \text{ relativistic) or 0.17644 MeV (based on 194.177 MeV/bc, non-relativistic). The SMT value is 2.2016 MeV. The experimental data splits this energy into 765.79 keV (93.8\%) and 1073.71 keV (3.74\%).} \]

**III. EC-decay Q-value**

The general formula of \( \Delta M_n \) for EC-decay is given by:

\[ \Delta M_n = [(M_A-Z_1M_H)M - (M_A-ZM_H)D] \]

**Example-1:**

\[ ^{131}Cs \to ^e + ^{131}Xe + v_e \text{ 9.689 d} \]

\[ ^{131}Cs \text{ This nuclide has a mass of 130.905463926 u, and it has 55 protons and 76 neutrons. The net weight of neutrons' mass inside this nuclide is calculated like this } \{130.905463926 – (55-1) M_H} \text{ since one proton pick up one electron to convert to neutron. Thus, we deduct one proton from atomic number Z, or } \]
\[ (130.905463926 - 54 x 1.00782503207) = (130.905463926 - 54.42255173178) = 76.48291219422 u. \]

\[ ^{131}Xe \text{ This nuclide has a mass of 130.905082362 u, and it has 54 protons and 77 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this } \{130.905082362 – 54M_H} \text{ or } \]
\[ (130.905082362 - 54 x 1.00782503207) = (130.905082362 - 54.42255173178) = 76.48253063022 u. \]

\[ \Delta M_n = [\text{Neutron Mass of Cs (including 1M_H)} - \text{Neutron Mass of Xe}] \]
\[ \Delta M_n = [76.48291219422 - 76.48253063022] \]
\[ \Delta M_n = 0.0003816 u \]

The Q-value is 0.35546 MeV/c^2 or 0.0741 MeV/bc. SMT value is 0.3555 MeV/c^2.

**Example-2:**

\[ ^{152}Dy + e \to ^{152}Tb + v_e : 2.38 h \]
\[ \Delta M_n = 0.000648 u \]

The Q-value is 0.603612 MeV/c^2 or 0.12583 MeV/bc. SMT value is 0.6036 MeV/c^2.

**Example-3:**

\[ ^{72}Se + e \to ^{72}As + v_e : 8.408 d \]
\[ \Delta M_n \text{ in neutron mass on both sides is 0.00036 u. The Q-value is 0.33534 MeV/c}^2 \text{ or 0.0699 MeV/bc. The SMT value is 0.33534 MeV/c}^2. \]

**Example-4:**

\[ ^{149}Eu + e \to ^{149}Sm + v_e : 93.1 d \]
\[ \Delta M_n \text{ in neutron mass on both sides is 0.0007463 u. The Q-value is 0.69518 MeV/c}^2 \text{ or 0.1449 MeV/bc. The SMT value is 0.6952 MeV/c}^2. \]
IV. Alpha-decay Q-value

The general formula of $\Delta M_a$ for Alpha decay is given by:

$$\Delta M_a = (M_{A} - Z M_{H})_{R} - \{ (M_{A} - Z M_{H})_{P} + M_{x} \}, \ x= \text{any particle released, } R= \text{reactants, } P= \text{products;}$$

**Example-1:** $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$ (4.267 MeV/c$^2$, from literature)

$^{238}_{92}U$ : This nuclide has a mass of 238.050788247 u, and it has 92 protons and 146 neutrons.

The net weight of neutrons’ mass inside this nuclide is calculated like this

$$\Delta M_a = (238.050788247 - 92 \times 1.00782503207) = 145.3308853 u$$

$^{234}_{90}Th$ : This nuclide has a mass of 234.043601230 u, and it has 90 protons and 144 neutrons.

The net weight of neutrons’ mass inside this nuclide is calculated like this

$$\Delta M_a = (234.043601230 - 90 \times 1.00782503207) = 143.3393488 u$$

$^{4}_{2}He$ This nuclide has a mass of 4.002603.25415 u, and it has 2 protons and 2 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this

$$\Delta M_a = (4.002603.25415 - 2 \times 1.00866491574) = 1.986953186 u$$

The Q-value is 4.26982 MeV/c$^2$ or 0.88994 MeV/bc. The SMT value is 4.2698 MeV/c$^2$.

Re-4.2 Q-value of Nuclear Fusion Reactions

The general formula of $\Delta M_a$ for fusion reaction is given by:

$$\Delta M_a = \frac{1}{2}[(M_{A} - Z M_{H})_{R} - \{ (M_{A} - Z M_{H})_{P} + M_{x} \}, \ x= \text{any particle released, } R= \text{reactants, } P= \text{products;}$$

**Example-1:** $^{1}D + ^{1}D \rightarrow ^{1}T (1.01 MeV) + p^+ (3.02 MeV) + e$ (Total=4.03 MeV/c$^2$, from literature)

$^{1}D$ in neutron mass on both sides is 0.004329276 u. The Q-value is 4.0327 MeV/c$^2$ or 0.841 MeV/bc. Please remember here the proton is not included in the calculation. The SMT value is 4.0327 MeV/c$^2$.

**Example-2:** $^{2}D + ^{2}D \rightarrow ^{3}He (0.82 MeV) + n^0 (2.45 MeV)$ (Total=3.27 MeV, from literature)

$^{2}D$ in neutron mass on both sides is 0.00350936 u. The Q-value is 3.269 MeV/c$^2$ or 0.6815 MeV/bc. The SMT value is 3.269 MeV/c$^2$.

**Example-3:** $^{3}D + ^{3}He \rightarrow ^{4}He (3.6 MeV) + p^+ (14.7 MeV) + e$ (Total=18.35 MeV/c$^2$, from literature)

$^{3}D$ in neutron mass on both sides is 0.01970281077 u. The Q-value is 18.35317 MeV/c$^2$ or 3.82583 MeV/bc. The SMT value is 18.35317 MeV/c$^2$.

Re-4.3 Q-value of Nuclear Fission Reactions

A-The general formula of $\Delta M_a$ for fission reaction without $\beta^-$-decay is given by:
\[ \Delta m_n = [(M_A - Z M_H) M + M_n - \{ \Sigma (M_A - Z M_H) f_p + x M_n \}], x= \text{no. of neutron released, } f_p=\text{fission products} \]

**Example-1:** \( n + {}^{235}_{92}\text{U} \rightarrow {}^{94}_{38}\text{Sr} + {}^{140}_{54}\text{Xe} + 2n \) (184.682 MeV/c², from literature)

\( {}^{235}_{92}\text{U} \): This nuclide has a mass of 235.043929918 u, and it has 92 protons and 143 neutrons. The net weight of neutrons’ mass inside the nuclide is calculated like this (235.043929918 - 92 M_H) or (235.043929918 - 92 x 1.00782503207) = (235.043929918 - 92.71990295044) = 142.32402696756 u.

\( {}^{94}_{38}\text{Sr} \). This nuclide has a mass of 93.915361312 u, and it has 38 protons and 56 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (93.915361312 - 38 M_H) or (93.915361312 – 38 x 1.00782503207) = (93.915361312 - 38.29735121866) = 55.61801009334 u.

\( {}^{140}_{54}\text{Xe} \): This nuclide has a mass of 139.921640943 u, and it has 54 protons and 86 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (139.921640943 - 54 M_H) or (139.921640943 – 54 x 1.00782503207) = (139.921640943 - 54.42255173178) = 85.49908921122 u.

\[ \Delta m_n = \{(\text{Neutron Mass of } {}^{235}_{92}\text{U} + M_n) - (\text{Neutron Mass of } {}^{95}_{38}\text{Sr} + \text{Neutron Mass of } {}^{140}_{54}\text{Xe} + \text{Mass of } 2n)\} \]

\[ \Delta m_n = \{(142.32402696756 + 1.008664916) - (55.61801009334 + 85.49908921122 + 2 x 1.00866491574)\} \]

\[ \Delta m_n = 143.3326918833 - 143.13442913604 = 0.1982639840 \text{ u.} \]

The Q-value is 184.6829 MeV/c² or 38.498306 MeV/bc. The SMT value is 184.683 MeV/c².

**Example-2:** \( n + {}^{235}_{92}\text{U} \rightarrow {}^{92}_{36}\text{Kr} + {}^{141}_{56}\text{Ba} + 3n \) (173.3 MeV/c², from literature)

\( {}^{235}_{92}\text{U} \): This nuclide has a mass of 235.043929918 u, and it has 92 protons and 143 neutrons. The net weight of neutrons’ mass inside the nuclide is calculated like this (235.043929918 - 92 M_H) or (235.043929918 - 92 x 1.00782503207) = (235.043929918 - 92.71990295044) = 142.32402696756 u.

\( {}^{92}_{36}\text{Kr} \). This nuclide has a mass of 93.915361312 u, and it has 38 protons and 56 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (93.915361312 - 38 M_H) or (93.915361312 – 38 x 1.00782503207) = (93.915361312 - 38.29735121866) = 55.61801009334 u.

\( {}^{141}_{56}\text{Ba} \): This nuclide has a mass of 139.921640943 u, and it has 54 protons and 86 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (139.921640943 - 54 M_H) or (139.921640943 – 54 x 1.00782503207) = (139.921640943 - 54.42255173178) = 85.49908921122 u.

\[ \delta m_n = \{(\text{Neutron Mass of } {}^{235}_{92}\text{U} + M_n) - (\text{Neutron Mass of } {}^{92}_{36}\text{Kr} + \text{Neutron Mass of } {}^{141}_{56}\text{Ba} + \text{Mass of } 3n)\} \]

\[ \delta m_n = \{(142.32402696756 + 1.008664916) - (55.61801009334 + 85.49908921122 + 3 x 1.00866491574)\} \]

\[ \delta m_n = 143.3326918833 - 143.13442913604 = 0.1982639840 \text{ u.} \]

The net weight of neutrons’ mass inside this nuclide is calculated like this (139.921640943 - 54 M_H) or (139.921640943 – 54 x 1.00782503207) = (139.921640943 - 54.42255173178) = 85.49908921122 u.

\[ \delta m_n = [(\text{Neutron Mass of } {}^{235}_{92}\text{U} + M_n) - (\text{Neutron Mass of } {}^{95}_{38}\text{Mo} + \text{Neutron Mass of } {}^{139}_{57}\text{La} + 2n + 7\beta) (204.2123 \text{ MeV/c}^2, \text{from literature})] \]

As we stated that in any process include beta decay we have to add the mass of proton and electron to the products in the right side.

Left side= (\( M_A - Z M_H \) )M + M_n

\( {}^{235}_{92}\text{U} \): This nuclide has a mass of 235.043929918 u, and it has 92 protons and 143 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (235.043929918 - 92 M_H) or (235.043929918 - 92 x 1.00782503207) = (235.043929918 - 92.71990295044) = 142.32402696756 u.

Right side= \( \{ \Sigma (M_A - Z M_H) f_p + x M_n + y(M_H + M_e) \} \)

\( {}^{95}_{42}\text{Mo} \). This nuclide has a mass of 94.905842129 u, and it has 42 protons and 53 neutrons. The net weight of neutrons’ mass inside the nuclide is calculated like this (94.905842129 - 42 M_H) or (94.905842129 – 42 x 1.00782503207) = (94.905842129 - 42.32865134694) = 52.57719078206 u.

\( {}^{139}_{57}\text{La} \): This nuclide has a mass of 138.906353267 u, and it has 57 protons and 82 neutrons. The net weight of neutrons’ mass inside the nuclide is calculated like this (138.906353267 - 57 M_H) or (138.906353267 – 57 x 1.00782503207) = (138.906353267 - 57.44602682799) = 81.46032639091 u.

\( 7M_e = 2x1.00866491574, 7M_H = 7x1.00782503207, 7M_e = 7x0.000548579905 \)
\[ \Delta M_n = [(\text{Neutron Mass of } ^{235}_{92} \text{U} + \text{Mass of } ^{1}\text{n}) - (\text{Neutron Mass of } ^{95}_{42} \text{Mo} + \text{Neutron Mass of } ^{139}_{57} \text{La} + \text{Mass of } ^{2}\text{n}) + \text{Mass of } ^{7}\text{M} + \text{Mass of } ^{7}\text{electron}] \]

\[ \Delta M_n = [(142.32402696756 + 1.00866491574) - (52.57719078206 + 81.46032643901 + 2 \times 1.00866491574 + 7 \times 1.00782503207 + 7 \times 0.00054858)] \]

\[ \Delta M_n = 143.33269189 - 143.113462344 = 0.219229524 \text{ u.} \]

\[ \Delta M_n \text{ in neutron mass on both sides is } 0.219229524 \text{ u. The Q-value is } 204.2123 \text{ MeV/c}^2 \text{ or } 36.251 \text{ MeV/bc. The SMT value is } 204.2 \text{ MeV/c}^2. \]

### Re-4.4 Q-value of Nuclear Spallation Reactions at Accelerators

\[ ^{127}_{53} \text{I} + n \rightarrow ^{128}_{53} \text{I} + \gamma(6.827 \text{ MeV}) \]

\[ \Delta M_n = [(M_A Z M_H)_R + M_n] - (M_A Z M_H)_P \]

\[ \Delta M_n = [(73.48974670029 + 1.008664916) - 74.49108300029] = 0.007328616 \text{ u} \]

\[ \text{NMT Q-value is } 6.8266058 \text{ MeV/c}^2 (1.4230487 \text{ MeV/bc}). \text{ SMT Q-value is } 6.8266058 \text{ MeV/c}^2. \]

\[ ^{14}_{6} \text{N} + n \rightarrow ^{14}_{6} \text{C} + p + 0.626(MeV) \]

\[ \Delta M_n = [(M_A Z M_H)_R + M_n] - (M_A Z M_H)_P \]

\[ \Delta M_n = [(6.94829878037 + 1.008664916) - 7.956291796] = 0.0006719004 \text{ u} \]

\[ \text{NMT Q-value is } 0.62587526 \text{ MeV/c}^2 (0.1304676 \text{ MeV/bc}). \text{ SMT Q-value is } 0.62587526 \text{ MeV/c}^2. \]

### Re-4.5 Binding Energy Calculations

The general formula of \( \Delta M_n \) for binding energy calculation is given by:

\[ \Delta M_n = N M_n - (M_A Z M_H)_R \]

The binding energy is given by \( E_b = (\Delta M_n / A) \times 194.177 \text{ MeV/bc (non-relativistic)} \) or \( x 931.5 \text{ MeV/c}^2 \) (relativistic) for purpose of comparison with literature.

**Example-1:** \( ^{2}_{1} \text{D} \): This nuclide has a mass of 2.0141017785 u, and it has one proton and one neutron. The net weight of neutrons’ mass inside this nuclide is calculated like this: (2.0141017785 - 1M_H) or (2.0141017785 - 1.00782503207) = 1.00627674578 u.

\[ \Delta M_n = [(\text{Free Neutron Mass}) - (1.00627674578)] = 1.00866491574 - 1.00627674578 \]

\[ \Delta M_n = 0.00238816996 \text{ u} \]

The Binding Energy is 2.22458 MeV/c^2 or 1112.29016 keV/A (based on 931.5 MeV/c^2 relativistic) or 0.463728 MeV/bc. The result is completely identical with SMT value (1112.29 keV/A).

**Example-2:** \( ^{4}_{2} \text{He} \): This nuclide has a mass of 4.00260325415 u, and it has 2 protons and 2 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (4.00260325415 - 2M_H) or (4.00260325415 - 2 x 1.00782503207) = 1.98695319001 u.

\[ \Delta M_n = [(2 \times \text{Free Neutron Mass}) - (1.98695319001)] = 2.0132983148 - 1.98695319001 \]

\[ \Delta M_n = 0.03037664147 \text{ u} \]

The Binding Energy is 28.22584 MeV/c^2 or 7073.9016 keV/A (based on 931.5 MeV/c^2 relativistic) or 0.463728 MeV/bc. The result is completely identical with SMT value (7073.915 keV/A).

**Example-3:** \( ^{235}_{92} \text{U} \): This nuclide has a mass of 235.043929918 u, and it has 92 protons and 143 neutrons. The net weight of neutrons’ mass inside this nuclide is calculated like this (235.043929918 - 92M_H) or (235.043929918 - 92 x 1.00782503207) = 142.32402696756 u.

\[ \Delta M_n = [(143 \times \text{Free Neutron Mass}) - (142.32402696756)] = 144.23908295082 - 142.32402696756 \]

\[ \Delta M_n = 1.91505598326 \text{ u} \]
The Binding Energy is 1783.87465 MeV/c² (or 7590.9559 keV/A) (based on 931.5 MeV/c² relativistic) or 371.85983 MeV/bc. The result is completely identical with SMT value (7590.907 keV/A).

Example-4: \( ^3_2 \text{HE} \): This nuclide has a mass of 3.01602931914 u, and it has 2 protons and 1 neutron. The net weight of neutrons’ mass inside this nuclide is calculated like this \((3.01602931914 - 2 \times 1.007825032) = 1.00037925514 \) u.

\[ \Delta M_e = ([\text{Free Neutron Mass}] - (1.00037925514)) = 1.008664916 - 1.00037925514 \]

\[ \Delta M_e = 0.00828566086 \text{ u} \]

The Binding Energy is 7.71809 MeV/c² or 2572.697 keV/A (based on 931.5 MeV/c² relativistic) or 1.60889 MeV/bc. The result is completely identical with SMT value (2572.681 keV/A).

4.7. Standard Energy of Formation of Nuclide SEFN

We compared the literature values from NBL, K&L, JAEA with SMT values (based on Mass Defect, 931.5 MeV/c²), NMT values (based on Neutron Mass Defect, 931.5 MeV/c²), and the energy change \( \Delta E_f \) values for some nuclear process (based on Standard Energy of Formation, \( E_o \), 931.5 MeV/c²). In general, the values of energy change \( \Delta E_f \) are more comprehensive than SMT’s \( \Delta M_A \) and NMT’s \( \Delta M_n \) and the experimental values. This method succeeded to estimate the total Q values for the fission reactions and to give clear and proper values for EC/\( \beta^+/\beta^- \) decays processes. It also succeeded to differentiate between EC and \( \beta^+ \) decays. To differentiate between EC and \( \beta^- \) we have check the \( E_f \) for the mother and daughter. If the \( E_f \) for the mother smaller than the daughter then the mother will undergo \( \beta^- \) decay otherwise the mother will undergo EC decay.

**Standard Energy of Formation of Nuclide** \( E_f \) gives the total \( \beta^- \) energies which are supposed to be released. For example, plotting \( \beta^- \) energy versus \( \Delta UQM_n \) for Ga-isotopes which gave \( E_{\beta^-} = 5 \times 10^6 \Delta UQM_n + 762.59, R^2 = 0.997 \). From the slope \( 5 \times 10^6 \) (keV/u) we estimated \( E_{\beta^-} \) for more than ten isotopes \( ^{72}\text{Ga} \rightarrow ^{83}\text{Ga} \) (3148.828, 3924.971, 5009.652, 5793.143, 6849.912, 7643.266, 8629.230, 9447.957, 10470.513, 11266.627, 12357.953, 13301.640 KeV), for example, the estimated \( E_{\beta^-} \) for \( ^{80}\text{Ga} \) was 10470 keV compared with the measured value 10380 keV from NBL. The \( \beta^- \) energies calculated using energy change \( \Delta E_f \) for these isotopes are 9.998, 11.012, 11.096, 12.037, 12.206, 13.159, 13.110, 14.277, 14.357, 15.076, 15.335, 16.180 MeV.

4.7.1- \( \beta^- \)-decay Q-value \( \Delta E_{f^+} = E_{o}^+ (B)_{D} - E_{o}^+ (A)_{M} \)

**Table-14:** \( \Delta E_f^+ \) values for negatron decay. *Most of these values mentioned with other gamma rays

<table>
<thead>
<tr>
<th>Nuclear Process: ( \beta^- )-decay Q-value</th>
<th>Literature (MeV/c²)</th>
<th>( \Delta E_f^+ ) (MeV/c²)</th>
<th>SMT (MeV/c²)</th>
<th>NMT (MeV/c²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ( ^{239}<em>{93}\text{Np} \rightarrow ^{239}</em>{94}\text{Pu} + \beta^- + \nu_e )</td>
<td>0.722/1.624/1.527</td>
<td>1.74446</td>
<td>0.72247</td>
<td>0.72247</td>
</tr>
<tr>
<td>2 ( ^{208}<em>{81}\text{TI} \rightarrow ^{208}</em>{82}\text{Pb} + \beta^- + \nu_e )</td>
<td>4.999/5.516/4.267</td>
<td>6.02099</td>
<td>4.99900</td>
<td>4.99900</td>
</tr>
<tr>
<td>3 ( ^{137}<em>{55}\text{Cs} \rightarrow ^{137}</em>{56}\text{Ba} + \beta^- + \nu_e )</td>
<td>1.69/2.58/1.17/1.84</td>
<td>2.19764</td>
<td>1.17565</td>
<td>1.17565</td>
</tr>
<tr>
<td>4 ( ^{107}<em>{46}\text{Pd} \rightarrow ^{107}</em>{47}\text{Ag} + \beta^- + \nu_e )</td>
<td>0.034/0.033/0.0347</td>
<td>0.033907</td>
<td>0.033907</td>
<td>0.033907</td>
</tr>
<tr>
<td>5 ( ^{90}<em>{38}\text{Sr} \rightarrow ^{90}</em>{39}\text{Y} + \beta^- + \nu_e )</td>
<td>0.546/0.546/0.546</td>
<td>1.56794</td>
<td>0.54595</td>
<td>0.54595</td>
</tr>
<tr>
<td>6 ( ^{64}<em>{29}\text{Cu} \rightarrow ^{64}</em>{30}\text{Zn} + \beta^- + \nu_e )</td>
<td>0.5794/0.653/0.5794</td>
<td>1.60137</td>
<td>0.579384</td>
<td>0.579384</td>
</tr>
<tr>
<td>7 ( ^{32}<em>{13}\text{P} \rightarrow ^{32}</em>{16}\text{S} + \beta^- + \nu_e )</td>
<td>1.71/1.71/1.71</td>
<td>2.73248</td>
<td>1.710486</td>
<td>1.71048</td>
</tr>
</tbody>
</table>
Table-14: $\Delta E^0_\beta$ values for negatron decay. *Most of these values mentioned with other gamma rays - continued

| 8  | $^{93}_{35}$Br $\rightarrow$ $^{93}_{36}$Kr + $\beta$ + $\bar{\nu}_e$. | ND/ND/11.283 | 11.9951 | 10.97307 | 10.97307 |
| 9  | $^{93}_{37}$Kr $\rightarrow$ $^{93}_{37}$Rb + $\beta$ + $\bar{\nu}_e$. | 8.485/9.176/6.328 | 9.61787 | 8.595882 | 8.595882 |
| 10 | $^{93}_{38}$Rb $\rightarrow$ $^{93}_{38}$Sr + $\beta$ + $\bar{\nu}_e$. | 7.465/8.88/8.8796 | 8.48889 | 7.466904 | 7.466904 |
| 11 | $^{93}_{39}$Sr $\rightarrow$ $^{93}_{39}$Y + $\beta$ + $\bar{\nu}_e$. | 4.14/5.013/6.496 | 5.16065 | 4.138655 | 4.138655 |
| 12 | $^{93}_{40}$Y $\rightarrow$ $^{93}_{40}$Zr + $\beta$ + $\bar{\nu}_e$. | 2.895/3.601/2.895 | 3.91616 | 2.894171 | 2.894171 |
| 13 | $^{137}_{52}$Te $\rightarrow$ $^{137}_{53}$I + $\beta$ + $\bar{\nu}_e$. | ND/ND/7.216 | 7.96073 | 6.938744 | 6.938744 |
| 14 | $^{137}_{54}$I $\rightarrow$ $^{137}_{54}$Xe + $\beta$ + $\bar{\nu}_e$. | ND/7.734/5.877 | 6.89882 | 5.876834 | 5.876834 |
| 15 | $^{137}_{54}$Xe $\rightarrow$ $^{137}_{55}$Cs + $\beta$ + $\bar{\nu}_e$. | 4.173/5.04/4.163 | 5.18812 | 4.166134 | 4.166134 |
| 16 | $^{139}_{54}$Cs $\rightarrow$ $^{139}_{55}$Ba + $\beta$ + $\bar{\nu}_e$. | ND/7.734/7.118 | 7.82846 | 6.806471 | 6.806471 |
| 17 | $^{139}_{55}$Ba $\rightarrow$ $^{139}_{55}$Cs + $\beta$ + $\bar{\nu}_e$. | 5.057/9.599/5.056 | 6.07910 | 5.057114 | 5.057114 |
| 18 | $^{157}_{64}$Eu $\rightarrow$ $^{157}_{64}$Gd + $\beta$ + $\bar{\nu}_e$. | 4.213/5.820/4.212 | 5.23489 | 4.212895 | 4.212895 |
| 19 | $^{157}_{65}$Gd $\rightarrow$ $^{157}_{65}$Sm + $\beta$ + $\bar{\nu}_e$. | ND/4.360/4.36 | 5.37787 | 4.355880 | 4.355880 |
| 20 | $^{157}_{65}$Sm $\rightarrow$ $^{157}_{65}$Eu + $\beta$ + $\bar{\nu}_e$. | 2.73/5.262/2.734 | 3.76153 | 2.739542 | 2.739542 |
| 21 | $^{157}_{65}$Eu $\rightarrow$ $^{157}_{65}$Gd + $\beta$ + $\bar{\nu}_e$. | 1.363/2.187/1.363 | 2.38559 | 1.363598 | 1.363598 |
| 22 | $^{40}_{19}$K $\rightarrow$ $^{40}_{20}$Ca + $\beta$ + $\bar{\nu}_e$. | 1.311/1.311/1.311 | 2.333077 | 1.311086 | 1.311086 |

4.7.2. $\beta^+$-decay Q-value $\Delta E^0_\beta = (B)_D + 1.022 E^0_\beta (A)_M$

Table-15: $\Delta E^0_\beta$ values for positron decay. *NBL, **IAEA * Observed as E$_{EC}$

<table>
<thead>
<tr>
<th>Nuclear Process: $\beta^+$-decay Q-value</th>
<th>Literature (MeV/c$^2$)</th>
<th>$\Delta E^0_\beta$ (MeV/c$^2$)</th>
<th>SMT (MeV/c$^2$)</th>
<th>NMT (MeV/c$^2$)</th>
<th>Comments: (MeV/c$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{24}$Na $\rightarrow$ $^{24}$Ne + $e^+$ + $\bar{\nu}_e$.</td>
<td>2.8423/2.8432</td>
<td>2.842280</td>
<td>1.8202685</td>
<td>1.8202685</td>
<td>IAEA, JAEA and BNL give different Q-values for this type of decay which mostly different than SMT values.</td>
</tr>
<tr>
<td>$^{24}$Cl $\rightarrow$ $^{24}$Ne + $e^+$ + $\bar{\nu}_e$.</td>
<td>5.4916</td>
<td>5.492057</td>
<td>4.4700451</td>
<td>4.4700451</td>
<td></td>
</tr>
<tr>
<td>$^{56}$Co $\rightarrow$ $^{56}$Fe + $e^+$ + $\bar{\nu}_e$.</td>
<td>2.3076</td>
<td>2.307519</td>
<td>1.2855074</td>
<td>1.2855074</td>
<td></td>
</tr>
<tr>
<td>$^{64}$Cu $\rightarrow$ $^{64}$Ni + $e^+$ + $\bar{\nu}_e$.</td>
<td>1.675/1.6752</td>
<td>1.674434</td>
<td>0.6524228</td>
<td>0.6524228</td>
<td></td>
</tr>
<tr>
<td>$^{43}$Tc $\rightarrow$ $^{43}$Mo + $e^+$ + $\bar{\nu}_e$.</td>
<td>1.6911</td>
<td>1.690587</td>
<td>0.6685750</td>
<td>0.6685750</td>
<td></td>
</tr>
<tr>
<td>$^{66}$Kr $\rightarrow$ $^{66}$Ca + $e^+$ + $\bar{\nu}_e$.</td>
<td>1.5047</td>
<td>1.504715</td>
<td>0.4827030</td>
<td>0.4827030</td>
<td></td>
</tr>
<tr>
<td>$^{88}$Rb $\rightarrow$ $^{88}$Sr + $e^+$ + $\bar{\nu}_e$.</td>
<td>1.9824/1.9822</td>
<td>1.982425</td>
<td>0.9604139</td>
<td>0.9604139</td>
<td></td>
</tr>
<tr>
<td>$^{90}$Zr $\rightarrow$ $^{90}$Ni + $e^+$ + $\bar{\nu}_e$.</td>
<td>ND/ND</td>
<td>4.547220</td>
<td>3.5252079</td>
<td>3.5252079</td>
<td></td>
</tr>
<tr>
<td>$^{94}$Zr $\rightarrow$ $^{94}$Ni + $e^+$ + $\bar{\nu}_e$.</td>
<td>ND/ND</td>
<td>4.517272</td>
<td>3.1352606</td>
<td>3.1352606</td>
<td></td>
</tr>
<tr>
<td>$^{106}$Cd $\rightarrow$ $^{106}$Zn + $e^+$ + $\bar{\nu}_e$.</td>
<td>ND/ND</td>
<td>2.154983</td>
<td>1.1329715</td>
<td>1.1329715</td>
<td></td>
</tr>
</tbody>
</table>

Note: It seems that when Z increases the measurement of the positron become more difficult as it will collide with one electron of the atomic orbitals and deceive the observer to record it as EC process. $^{11}$C and $^{22}$Na show clear positron decay while the other nuclides show EC process. SMT state that if $M_A$ of the mother > $M_A$ of the daughter plus 2Ms, the nuclide undergo Positron decay otherwise, it will undergo EC decay. The nuclides above $^{34}$Cl, $^{58}$Co, $^{64}$Cu, $^{95}$Tc, and $^{40}$K achieve the positron decay condition thus, why NBL Data observed these energies as E$_{EC}$? Anyhow, SEFN follows the
general formulas for positron and negatron. If SEFN do not follow them then it will give identical results to SMT regarding positron and negatron decay.

### 4.7.3- EC-decay Q-value $\Delta E_i^\ominus =$

add 1.022 to the daughter because the $\Delta E_i^\ominus$ of the mother is larger than $\Delta E_i^\ominus$ of the daughter.

#### Table-16: $\Delta E_i^\ominus$ values for EC-decay. ND= No Data, NP= Not Possible. EC cannot happen because $E_i^\ominus$ or mother is less than for daughter.

<table>
<thead>
<tr>
<th>#</th>
<th>Nuclear Process: EC-decay Q-value</th>
<th>$\Delta E_i^\ominus$ (MeV/c^2) from NBL/K&amp;L/IAEA</th>
<th>SMT (MeV/c^2)</th>
<th>NMT (MeV/c^2)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>152 Dy $^\beta$ + e $\rightarrow$ 152 Tb + $\nu_e$</td>
<td>EC:0.532/0.314/0.373</td>
<td>EC +0.53235</td>
<td>+0.53235</td>
<td>EC: Yes</td>
</tr>
<tr>
<td>2</td>
<td>149 Eu $^\beta$ + e $\rightarrow$ 149 Sm + $\nu_e$</td>
<td>+0.600/0.257/0.257</td>
<td>EC +0.60362</td>
<td>+0.60362</td>
<td>EC: Yes</td>
</tr>
<tr>
<td>3</td>
<td>131 Cs $^\beta$ + e $\rightarrow$ 131 Xe + $\nu_e$</td>
<td>+0.694/0.640/0.627</td>
<td>EC +0.69519</td>
<td>+0.69519</td>
<td>EC: Yes</td>
</tr>
<tr>
<td>4</td>
<td>82 Sr $^\beta$ + e $\rightarrow$ 82 Rb + $\nu_e$</td>
<td>+0.355/0.355/0.355</td>
<td>EC +0.355468</td>
<td>+0.355468</td>
<td>EC: Yes</td>
</tr>
<tr>
<td>5</td>
<td>72 Se $^\beta$ + e $\rightarrow$ 72 As + $\nu_e$</td>
<td>+0.361/0.361/0.361</td>
<td>EC +0.335347</td>
<td>+0.335347</td>
<td>EC: Yes</td>
</tr>
<tr>
<td>6</td>
<td>54 Mn $^\beta$ + e $\rightarrow$ 54 Cr + $\nu_e$</td>
<td>+0.8182/0.8182/0.8182</td>
<td>EC +0.818699</td>
<td>+0.818699</td>
<td>EC: YES</td>
</tr>
<tr>
<td>7</td>
<td>24 Mn $^\beta$ + e $\rightarrow$ 24 Cr + $\nu_e$</td>
<td>+0.8182/0.8182/0.8182</td>
<td>EC +0.818699</td>
<td>+0.818699</td>
<td>EC: YES</td>
</tr>
<tr>
<td>8</td>
<td>18 Ne $^\beta$ + e $\rightarrow$ 18 F + $\nu_e$</td>
<td>+0.4457/5.805/3.401</td>
<td>EC +1.377186</td>
<td>+1.377186</td>
<td>EC: YES</td>
</tr>
<tr>
<td>9</td>
<td>10 Ne $^\beta$ + e $\rightarrow$ 10 F + $\nu_e$</td>
<td>+4.442896</td>
<td>EC +4.4443</td>
<td>+4.4443</td>
<td>EC: NO*</td>
</tr>
<tr>
<td>10</td>
<td>54 Xe $^\beta$ + e $\rightarrow$ 54 I + $\nu_e$</td>
<td>+2.694/1.343/1.323</td>
<td>EC +2.695</td>
<td>+2.695</td>
<td>EC: NO*</td>
</tr>
<tr>
<td>11</td>
<td>40 K $^\beta$ + e $\rightarrow$ 40 Ar + $\nu_e$</td>
<td>+1.505/1.505/1.505</td>
<td>EC +1.505</td>
<td>+1.505</td>
<td>EC: YES</td>
</tr>
</tbody>
</table>

#### Table-17: $\Delta E_i^\ominus$ values for alpha decay

<table>
<thead>
<tr>
<th>#</th>
<th>Nuclear Process: $\alpha$-decay Q-value</th>
<th>Literature (MeV/c^2)</th>
<th>$\Delta E_i^\ominus$ (MeV/c^2)</th>
<th>SMT (MeV/c^2)</th>
<th>NMT (MeV/c^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$^{220}$Rn $\rightarrow$ $^{216}$Po + $^{4}$He</td>
<td>4047</td>
<td>6.404757</td>
<td>6.404757</td>
<td>6.404757</td>
</tr>
<tr>
<td>2</td>
<td>$^{226}$Ra $\rightarrow$ $^{222}$Rn + $^{4}$He</td>
<td>8707</td>
<td>4.87057</td>
<td>4.87057</td>
<td>4.87057</td>
</tr>
<tr>
<td>3</td>
<td>$^{235}$U $\rightarrow$ $^{231}$Th + $^{4}$He</td>
<td>6787</td>
<td>4.678323</td>
<td>4.678323</td>
<td>4.678323</td>
</tr>
<tr>
<td>4</td>
<td>$^{238}$U $\rightarrow$ $^{234}$Th + $^{4}$He</td>
<td>2690</td>
<td>4.269946</td>
<td>4.269946</td>
<td>4.269946</td>
</tr>
<tr>
<td>5</td>
<td>$^{237}$Np $\rightarrow$ $^{233}$Pa + $^{4}$He</td>
<td>9583</td>
<td>4.958231</td>
<td>4.958231</td>
<td>4.958231</td>
</tr>
<tr>
<td>6</td>
<td>$^{239}$Pu $\rightarrow$ $^{235}$U + $^{4}$He</td>
<td>2444</td>
<td>5.244574</td>
<td>5.244574</td>
<td>5.244574</td>
</tr>
<tr>
<td>7</td>
<td>$^{247}$Cm $\rightarrow$ $^{243}$Pu + $^{4}$He</td>
<td>3530</td>
<td>5.354025</td>
<td>5.354025</td>
<td>5.354025</td>
</tr>
<tr>
<td>8</td>
<td>$^{252}$Cf $\rightarrow$ $^{248}$Cm + $^{4}$He</td>
<td>2169</td>
<td>6.216604</td>
<td>6.216604</td>
<td>6.216604</td>
</tr>
</tbody>
</table>
4.7.5. Cluster-decay Q-value $\Delta E_f^{\nu} =$

**Table-18:** $\Delta E_f^{\nu}$ values for cluster decay

<table>
<thead>
<tr>
<th></th>
<th>Reaction</th>
<th>$E_\Delta$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$^{223}<em>{85}Ra \rightarrow ^{208}</em>{82}Pb + ^{14}_6C.$</td>
<td>.8295</td>
<td>31.8294</td>
<td>31.8294</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$^{229}<em>{90}Th \rightarrow ^{208}</em>{82}Pb + ^{20}_8O.$</td>
<td>.7235</td>
<td>44.7235</td>
<td>44.7235</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$^{237}<em>{93}Np \rightarrow ^{207}</em>{81}Tl + ^{30}_{12}Mg.$</td>
<td>.7998</td>
<td>74.7998</td>
<td>74.7998</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$^{223}<em>{85}Ac \rightarrow ^{209}</em>{81}Bi + ^{14}_6C.$</td>
<td>.0655</td>
<td>33.0655</td>
<td>33.0655</td>
<td></td>
</tr>
</tbody>
</table>

4.7.6- Q-value of Nuclear Fusion Reactions $\Delta E_f^{\nu} =$

**Table-19:** $\Delta E_f^{\nu}$ values for nuclear fusion reactions.

<table>
<thead>
<tr>
<th></th>
<th>Reaction</th>
<th>$E_\Delta$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$^1_1p + ^{11}_5B \rightarrow ^3_2He(8.7 \text{ MeV}).$</td>
<td>6822</td>
<td>8.6822</td>
<td>8.6822</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$^3_2T + ^3_2T \rightarrow ^4_2He + 2^1_0n + (11.3 \text{ MeV})$</td>
<td>11.332</td>
<td>11.332</td>
<td>11.332</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$^2_1D + ^3_2T \rightarrow ^4_2He(3.5\text{MeV}) + ^1_0n(14.1 \text{ MeV})$</td>
<td>17.590</td>
<td>17.590</td>
<td>17.590</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$^2_1D + ^2_1D \rightarrow ^3_2He(0.82\text{MeV}) + ^1_0n(2.45 \text{ MeV})$</td>
<td>3.269</td>
<td>3.269</td>
<td>3.269</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>$^2_1D + ^6_3Li \rightarrow ^3_2He + 22.4 \text{ MeV}$</td>
<td>22.373</td>
<td>22.373</td>
<td>22.373</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>$^2_1D + ^8_3Li \rightarrow ^7_2Li + ^1_1p + 5.0 \text{ MeV}.$</td>
<td>0245</td>
<td>5.0245</td>
<td>5.0245</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>$^2_1D + ^3_2D \rightarrow ^3_2T(1.01\text{MeV}) + ^1_1p(3.02 \text{ MeV}).$</td>
<td>0237</td>
<td>4.0327</td>
<td>4.0327</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>$^1_1H + ^3_2T \rightarrow ^4_2He + (19.814 \text{ MeV})$</td>
<td>19.814</td>
<td>19.814</td>
<td>19.814</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>$^4_2He + ^4_2He \rightarrow ^8_4Be + (−0.092 \text{ MeV})$</td>
<td>-0.0918</td>
<td>-0.0918</td>
<td>-0.0918</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>$^2_1D + ^2_1D \rightarrow ^4_4Be + (47.6 \text{ MeV})$</td>
<td>47.6015</td>
<td>47.6015</td>
<td>47.6015</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>$^2_1D + ^2_1D \rightarrow ^4_4Be + (7.367 \text{ MeV})$</td>
<td>7.3666</td>
<td>7.3666</td>
<td>7.3666</td>
<td></td>
</tr>
</tbody>
</table>

4.7.7. Q-value of Nuclear Fission Reactions $\Delta E_f^{\nu} =$

**Table-20:** $\Delta E_f^{\nu}$ values for nuclear fission reactions. Secd=Secondary

<table>
<thead>
<tr>
<th></th>
<th>Reaction</th>
<th>$E_\Delta$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
<th>$\Delta E_f^{\nu}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{92}</em>{36}Kr + ^{141}_{56}Ba + 3n$</td>
<td>166.744</td>
<td>173.290</td>
<td>173.290</td>
<td>primary fission</td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{92}</em>{37}Rb + ^{141}_{57}La + 3n + 2\beta$</td>
<td>179.009</td>
<td>181.466</td>
<td>181.466</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{92}</em>{38}Sr + ^{141}_{58}Ce + 3n + 4\beta$</td>
<td>192.673</td>
<td>191.042</td>
<td>191.042</td>
<td>end of secd fission</td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{92}</em>{39}Y + ^{141}_{59}Pr + 3n + 6\beta$</td>
<td>198.266</td>
<td>192.547</td>
<td>192.547</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{92}</em>{40}Zr + ^{141}_{59}Pr + 3n + 7\beta$</td>
<td>203.439</td>
<td>195.677</td>
<td>195.677</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{90}</em>{36}Kr + ^{143}_{56}Ba + 3n$</td>
<td>167.138</td>
<td>173.684</td>
<td>173.684</td>
<td>primary fission</td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{90}</em>{37}Rb + ^{143}_{57}La + 3n + 2\beta$</td>
<td>178.847</td>
<td>181.304</td>
<td>181.304</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{90}</em>{38}Sr + ^{143}_{58}Ce + 3n + 4\beta$</td>
<td>191.918</td>
<td>190.288</td>
<td>190.288</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$n + ^{235}<em>{92}U \rightarrow ^{90}</em>{39}Y + ^{143}_{59}Pr + 3n + 6\beta$</td>
<td>196.992</td>
<td>191.274</td>
<td>191.274</td>
<td></td>
</tr>
</tbody>
</table>
Table-20: $\Delta E_f^\alpha$ alues for nuclear fission reactions. Secd=Secondary - continued

<table>
<thead>
<tr>
<th>Reaction</th>
<th>$\Delta E_f^\alpha$</th>
<th>End of secd fission</th>
</tr>
</thead>
<tbody>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{90}</em>{40}$Zr + $^{143}_{60}$Nd + 3n + 8$\beta$</td>
<td>199.184</td>
<td>193.466</td>
</tr>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{93}</em>{38}$Sr + $^{140}_{54}$Xe + 3n</td>
<td>173.113</td>
<td>177.584</td>
</tr>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{93}</em>{39}$Y + $^{140}_{55}$Cs + 3n + 2$\beta$</td>
<td>181.551</td>
<td>185.030</td>
</tr>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{93}</em>{40}$Zr + $^{140}_{56}$Ba + 3n + 4$\beta$</td>
<td>194.516</td>
<td>193.123</td>
</tr>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{94}</em>{41}$Nd + $^{140}_{57}$La + 3n + 6$\beta$</td>
<td>197.699</td>
<td>193.242</td>
</tr>
<tr>
<td>n + $^{235}<em>{92}$U $\rightarrow ^{94}</em>{41}$Nd + $^{140}_{58}$Ce + 3n + 7$\beta$.</td>
<td>202.483</td>
<td>196.494</td>
</tr>
</tbody>
</table>

4.7.8. Q-value of Nuclear Spontaneous Fission $\Delta E_f^\alpha =$

Table-21: $\Delta E_f^\alpha$ alues for nuclear spontaneous fissions

<table>
<thead>
<tr>
<th>Reaction</th>
<th>$\Delta E_f^\alpha$</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{252}<em>{98}$Cf $\rightarrow ^{140}</em>{54}$Xe + $^{108}_{44}$Ru + 4n</td>
<td>0.4181</td>
<td>200.4181</td>
</tr>
<tr>
<td>$^{254}<em>{104}$Rf $\rightarrow ^{140}</em>{62}$Sm + $^{110}_{42}$Mo + 4n</td>
<td>1.9449</td>
<td>201.9449</td>
</tr>
<tr>
<td>$^{250}<em>{102}$No $\rightarrow ^{141}</em>{61}$Pm + $^{106}_{41}$Nb + 3n</td>
<td>4.9209</td>
<td>204.9209</td>
</tr>
</tbody>
</table>

4.7.9. Q-value of Nuclear Reactions at Accelerators $\Delta E_f^\alpha =$

Table-22: $\Delta E_f^\alpha$ alues for nuclear reactions at accelerators and colliders

<table>
<thead>
<tr>
<th>Reaction</th>
<th>$\Delta E_f^\alpha$</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{10}$B(p,$\gamma$)T$^1$C</td>
<td>8.6894</td>
<td>8.6894</td>
</tr>
<tr>
<td>$^{11}$B(p,n)$^{11}$C</td>
<td>8.7648</td>
<td>-2.7648</td>
</tr>
<tr>
<td>$^{12}$C(p,pn)$^{11}$C</td>
<td>8.722</td>
<td>-18.722</td>
</tr>
<tr>
<td>$^{14}$N(p,$\alpha$)$^{14}$C</td>
<td>8.9229</td>
<td>-2.9229</td>
</tr>
<tr>
<td>$^{10}$B(d,n)$^{11}$C</td>
<td>46485</td>
<td>6.46485</td>
</tr>
<tr>
<td>$^{12}$C(He,$\alpha$)$^{11}$C</td>
<td>85598</td>
<td>1.85598</td>
</tr>
<tr>
<td>$^{18}$B(a,n)$^{11}$N</td>
<td>05886</td>
<td>1.05886</td>
</tr>
<tr>
<td>$^{16}$O(He,p)$^{16}$F</td>
<td>03151</td>
<td>2.03151</td>
</tr>
<tr>
<td>$^{16}$O(a,pn)$^{18}$F</td>
<td>8.546</td>
<td>-18.546</td>
</tr>
<tr>
<td>$^{30}$S(p,3p)$^{28}$Mg</td>
<td>3.992</td>
<td>-23.992</td>
</tr>
</tbody>
</table>
Table-22: $\Delta E^\gamma_{\nu}$ values for nuclear reactions at accelerators and colliders - continued

<table>
<thead>
<tr>
<th>Reactor</th>
<th>$\Delta E^\gamma_{\nu}$</th>
<th>$\Delta E^\gamma_{\nu}$</th>
<th>$\Delta E^\gamma_{\nu}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 $^{37}_{17}$Cl + $^{3}$He,$^{2n}$</td>
<td>.1723</td>
<td>-4.1723</td>
<td>-4.1723</td>
</tr>
<tr>
<td>12 $^{127}<em>{53}$I(n,$\gamma$)$^{128}</em>{53}$I</td>
<td>6.8266</td>
<td>6.8266</td>
<td></td>
</tr>
<tr>
<td>13 $^{14}<em>{7}$N(n,$p$)$^{14}</em>{6}$C</td>
<td>6259</td>
<td>0.6259</td>
<td>0.6259</td>
</tr>
<tr>
<td>14 $^{14}<em>{7}$N(n,$\gamma$)$^{15}</em>{6}$N</td>
<td>.9898</td>
<td>10.9898</td>
<td>10.9898</td>
</tr>
</tbody>
</table>

Appendix-C

Re-5. NMT Independent-Particle Nuclear Model

1. $^{86}_{38}$Sr as S1-1(pn,pp)-P2-2(pp). This nuclide is expected to undergo this decay process to achieve the QM_n. The literature did not refer to its decay mode.

$^{86}_{38}$Sr(S1-1(pn,pp)-P2-2(pp) $^{2p\text{ decay}}_{\text{decay}}$ $^{84}_{36}$Sr(S1-1(pn,pp)) $^{p\text{ decay}}_{\text{decay}}$ $^{3}_{2}$He S1-1(pn, p) stable.

2. has P2-3(pp,pp). This nuclide will undergo this decay process to achieve the QM_n.

$^{12}_{8}$O, P2-3(pp,pp) $^{(60\%)}_{\text{decay}}$ $^{10}_{6}$C, P2-3(pp) $^{\beta^+\text{ decay}}_{\text{decay}}$ $^{10}_{5}$B P2-3(pn) stable.

3. s D3-5(pn,pp). This nuclide will undergo this decay process to achieve the QM_n.

$^{33}_{11}$Na, D3-5(pn,pp) $^{\beta^-\text{ decay}}_{\text{decay}}$ $^{31}_{10}$Ne, D3-5(pn,pp) stable $^{(25\%)}_{\text{undergo}}$ $^{\alpha\text{ decay}}_{\text{decay}}$ $^{8}_{6}$O D3-4(pn,pp) stable.

4. s D3-4(pn,pp)-5(pn). This nuclide will undergo this decay process to achieve the QM_n.

$^{22}_{11}$Na, D3-4(pn,pp)+5(pn) $^{\beta^-\text{ decay}}_{\text{decay}}$ $^{22}_{10}$Ne, D3-4(pn,pp)+5(nn) stable s F4-8(pn,pp)+9(p).

This nuclide will undergo these decay processes to achieve the QM_n.

$^{33}_{18}$Ar, F4-8(pn,pp)+9(p) $^{\beta^-\text{ decay}}_{\text{decay}}$ $^{33}_{17}$Cl, F4-8(pn,pp)+9(n) stable d;

$^{33}_{18}$Ar, F4-8(pn,pp)+9(p) $^{\beta^-\text{ decay}}_{\text{decay}}$ $^{33}_{17}$Cl, F4-8(pn,pp)+10(p) $^{\text{EC decay}}$ $^{32}_{16}$S, F4-9(pn,nn).

5. s F4-9(pn,pp)+10(n). This nuclide will undergo this decay process to achieve the QM_n.

$^{37}_{18}$Ar, F4-9(pn,pp)+10(n) $^{\text{EC decay}}$ $^{37}_{17}$Cl, F4-9(pn,pp)+10(n) stable.

6. H6-39(pn,pp)-40(pn,nn)-44(nn,nn). The sphere 39(pn,pp) will leave the nucleus as alpha particle and the sphere 40(pn,nn) will replace it to be 39(pn,nn) then following several $\beta^+$ nd EC decay processes to increase the neutrons ratio to reach the neutron quantized mass QM_n at $^{172}_{70}$Yb nuclide.
Nuclear Magneton Theory of Mass Quantization "Unified Field Theory"

\[ ^{176}\text{Au}, \text{H}6 - 39 \left( \text{pn, pn} \right) - 40 \left( \text{pn, nn} \right) - 44 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{Ir}, \text{H}6 - 39 \left( \text{pn, nn} \right) - 43 \left( \text{nn, nn} \right) \text{ decay} \]

\[ ^{172}\text{Os}, \text{H}6 - 38 \left( \text{pn, pn} \right) - 39 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{Re}, \text{H}6 - 38 \left( \text{pn, pn} \right) - 39 \left( \text{nn, nn} \right) \]

\[ 43 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{W}, \text{H}6 - 37 \left( \text{pn, pn} \right) - 38 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{Ta}, \text{H}6 - 37 \left( \text{pn, nn} \right) \]

\[ 39 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{Hf}, \text{H}6 - 36 \left( \text{pn, pn} \right) - 37 \left( \text{nn, nn} \right) \text{ decay} \Rightarrow ^{172}\text{Lu}, \text{H}6 - 36 \left( \text{nn, nn} \right) \text{ stable} \]

Table-24: Fertile and fissile identification based on NMT nuclear shell configurations

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<td>Cm-249 63(n)</td>
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Figure-25: NMT nuclear shells model gives the mass number, A, six levels filled by 4, 8, 16, 32, 64, 128 respectively.

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Figure-25: NMT nuclear shells model gives the mass number, A, six levels filled by 4, 8, 16, 32, 64, 128 respectively. - continued

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