Role of SUSY in finding the equivalent term for the first three terms of the semi empirical mass formula

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Introduction

Considering $Z \approx 21$ to 100, from particle physics data and modified SUSY, in the semi empirical mass formula [1,2], the five energy coefficients can be expressed as $a_v \cong 16.3$ MeV, $a_s \cong 19.4$ MeV, $a_c \cong 0.77$ MeV, $a_a \cong 23.8$ MeV and $a_p \cong 11.9$ MeV. Sum of the first three terms can be fitted with one equivalent term as $\left(A/A_S\right)^{1/2} * A * 8.93$ MeV where $A_S \cong 2Z + \left(Z/4\pi\right)^2$ can be considered as the stable mass number of Z.

Current status of SUSY

The Large Hadron Collider at CERN is currently producing the world's highest energy collisions and offers the best chance at discovering superparticles for the foreseeable future. As of July 2013, no meaningful signs of the superpartners have been observed. The failure of the Large Hadron Collider to find evidence for supersymmetry has led some physicists to suggest that the theory should be abandoned or modified. In this critical situation authors made a very simple attempt in sustaining and widening the concepts of SUSY with important changes [3-5].

The semi empirical mass formula

In nuclear physics, the semi-empirical mass formula is used to approximate the mass and various other properties of an atomic nucleus. As the name suggests, it is based partly on theory and partly on empirical measurements [1,2]. The theory is based on the liquid drop model proposed by George Gamow, which can account for most of the terms in the formula and gives rough estimates for the values of the coefficients. It was first formulated in 1935 by German physicist Carl Friedrich von Weizsacker, and although refinements have been made to the coefficients over the years, the structure of the formula remains the same today.

Basic concepts in modified SUSY

In modified Super symmetry, the authors already proposed that [3-5],

1. Fermion and its corresponding boson mass ratio is close to 2.2627 but not unity.

$$\frac{m_f}{m_b} \cong \Psi \cong 2.2627 \tag{1}$$

Here, m_f represents the mass of fermion and m_b represents its corresponding mass of boson and Ψ is the proposed empirical SUSY ratio to be estimated with a suitable theory or to be fitted from particle mass data. This idea can be applied to leptons, quarks, nucleons and electroweak bosons.

2. At low and high energies, all the observed mesons are SUSY bosons only.
3. Charged electroweak W boson is nothing but the top quark boson.
4. There exists a charged Higgs fermion of rest mass m_{Xf} and its corresponding charged Higgs boson mass is

$$m_{Xb} \cong \frac{m_{Xf}}{\Psi} \tag{2}$$

Charged Higgs boson pair generates the observed electroweak neutral boson, $\left(m_Z\right)$. Based on this idea, Charged Higgs boson rest energy can be expressed as

$m_{Xb}c^2 \cong \left(m_Z c^2/2\right) \cong 45594$ MeV and its corresponding Higgs fermion rest energy is $m_{Xf}c^2 \cong \Psi m_{Xb}c^2 \cong \Psi\left(m_Z c^2/2\right) \cong 103150$ MeV. Charged Higgs boson and the presently believed charged electroweak boson jointly generates a neutral boson of rest energy 126 GeV.

To fit and co-relate the semi empirical mass formula energy constants

$$\text{Let} \quad \frac{m_n - m_p}{m_e} \cong \ln(4\pi) \cong k \qquad (3)$$

here, m_n, m_p and m_e represent the rest masses of neutron, proton and electron respectively. This is a discovery and is an accurate relation. Let

$$\Psi \cong \frac{\sqrt{m_p m_\mu}}{m_\pi^\pm} \cong 2.256 \qquad (4)$$

where $m_\mu \cong 105.66\ \text{MeV}/c^2$ is the rest mass of muon and $m_\pi^\pm \cong 139.57\ \text{MeV}/c^2$ is the charged pion rest mass. Let

$$E_x \cong m_{xb}c^2 \cong \frac{\sqrt{m_p m_e}}{\Psi}c^2 \cong 9.7\ \text{MeV} \qquad (5)$$

It can be considered as the ground state nuclear force carrier. Charged pion can be considered as the excited nuclear force carrier.

a) The coulombic energy constant can be expressed in the following way.

$$\frac{E_x}{a_c} \cong e^k \text{ and } a_c \cong e^{-k}E_x \cong 0.772\ \text{MeV} \qquad (6)$$

b) The asymmetry energy constant can be expressed in the following way.

$$\frac{a_a + a_c}{E_x} \cong k \quad \text{and}$$

$$a_a \cong \left(k - e^{-k}\right)\mathrm{E_x} \cong 23.8\ \text{MeV} \cong 2\mathrm{E_x} \qquad (7)$$

c) The pairing energy constant can be expressed as

$$a_p \cong \frac{1}{2}a_a \cong 11.89\ \text{MeV} \cong 11.9\ \text{MeV} \qquad (8)$$

d) The surface energy constant can be expressed as

$$a_s \cong \frac{a_a + a_p}{2} + 2a_c \cong 19.4\ \text{MeV} \qquad (9)$$

e) The volume energy constant can be expressed as

$$a_v \cong \frac{a_a + a_p}{2} - 2a_c \cong 16.3\ \text{MeV} \qquad (10)$$

$$\text{Thus } \left(a_s, a_v\right) \cong \frac{a_a + a_p}{2} \pm 2a_c \qquad (11)$$

$$a_v + a_s \cong a_p + a_a \cong 3a_p \qquad (12)$$

Simple and direct proton-nucleon stability relation

For light and heavy atoms (including super heavy stable isotopes), proton-nucleon stability relation can be expressed as

$$A_S \cong 2Z + \left(Z/4\pi\right)^2 \qquad (13)$$

Equivalent term for the first three terms of the SEMF

Based on the above relations, to a close approximation (with 1 to 3% error), it is noticed that,

$$a_v A - a_s A^{2/3} - a_c \frac{Z(Z-1)}{A^{1/3}} \cong \left(\frac{A}{A_S}\right)^{1/2} * A * \left(E_x - a_c\right)$$

$$\cong \left(\frac{A}{A_S}\right)^{1/2} * A * 8.93\ \text{MeV} \qquad (14)$$

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