Proton and neutron intrinsic structures
in the period doubling (PD) scenario

Neutron decay and the origin of the neutrino
A high accuracy analysis of data

Ari Lehto
Physics Foundations Society
www.physicsfoundations.org

Summary

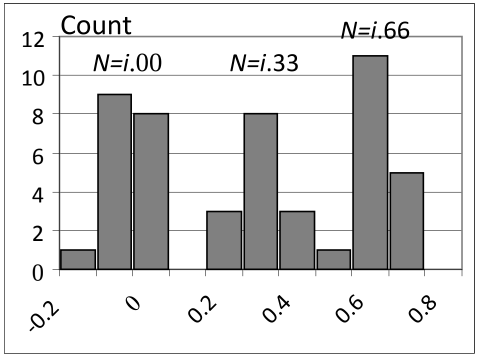
The rest energy of the electron-positron pair can be calculated fairly accurately from the Planck mass-energy using the multi-dimensional period doubling process as an analyzing tool. The problem is that the Planck mass yields the total energy of the pair without any explicit reference to the electromagnetic energy of the pair, which certainly is there.

The Coulomb energy e^2 and the value e of the elementary charge can be calculated from the Planck charge very accurately using the period doubling method. The Planck mass-energy and the Planck Coulomb energy can be combined together to form a new Planck energy, which we call the generalized Planck energy. It is then possible to separate the mass-energy part and the Coulomb energy part from the rest energy of the elementary particles.

The Planck energy can be calculated either from the conventional Planck mass or defined using the electron-positron pair rest energy. The latter gives extremely simple structures and accurate rest masses for the proton and the neutron indicating that the conventional Planck mass is a little off.

In the period doubling scenario the neutrino appears quite naturally from the neutron decay, and it seems to be an uncharged partner of an electron (or a positron) originating from the decay of an excited electron-positron pair.

Recap



$$E_N = 2^{-\frac{N}{3}} \cdot E_0$$

Analysis of experimental and observational data shows three intrinsic degrees of freedom (Lehto 1984, 1990).

Gravitational and Coulombic 1/*r*-potential systems are the well known examples of nonlinear dynamical systems.

Period doubling (PD) is a common property of *nonlinear dynamical systems*.

During the evolution of the system $2\tau_o$, $4\tau_o$, $8\tau_o$, $16\tau_o$ etc. periods appear. If τ_o is the fundamental period, then:

$$\tau_M = 2^M \cdot \tau_o \qquad (M = 0, 1, 2, 3 \ldots) \qquad (1)$$

Some periods are more stable than others. Periods of the form

$$\tau_M = 2^{2^M} \cdot \tau_o \qquad (2)$$

are *superstable* over an extensive period of time, i.e. they persist.

The systems we have analyzed so far reveal structures formed by their *internal degrees of freedom*.

The rest energy E_{ep} of the electron-positron pair (ep-pair) becomes

$$E_{ep} = 2^{-\frac{32+64+128}{3}} \cdot E_o = 1.021\, MeV \qquad (3)$$

where E_o is the Planck mass-energy calculated from *h*, *c* and *G*. The ep-pair structure is superstable according to (2).

Introduction

Nonlinear dynamical systems exhibit *period doubling*. Many well-known examples can be found e.g. in James Gleick's book "Chaos" (Gleick 1987). Simply put: period doubling means generation by the system of *subharmonic frequencies*.

The subharmonics can be related to the measurable physical properties of the system using well known physical relations.

Our research concentrates on the *multidimensional period doubling phenomenon*, which discloses the internal structure of a nonlinear system formed by its degrees of freedom (Lehto 2009, 2015).

The Planck scale is an excellent reference domain for the analysis of the elementary particle properties, electromagnetic phenomena and gravitational systems, because the Planck scale is defined by highly accurate natural constants.

We have earlier shown that the mass in MeV of the ep-pair can be calculated from the Planck mass E_{oG} , defined by h, c and G, based on the period doubling phenomenon. The calculation yields a superstable structure with 1.021 MeV energy, which differs 1.4 keV from the experimental 1.022 MeV energy. This may not sound like much, but it means 1.3 MeV in the nucleon rest energy range.

Introduction

The elementary electric charge can also be calculated from the Coulomb energy of the Planck charge (defined by h, c and ε_o), and the calculated value differs from the NIST value by 30 ppm.

The question now arises why the ep-pair rest energy is not accurately given by the conventional Planck energy, although period doubling is an exact process and the Planck energy is defined by highly accurate natural constants?

Starting from the experimental value of the ep-pair rest energy a new Planck energy (4) can be calculated, which yields the exact value for the ep-pair rest energy (5).

Nucleon structures obtained from the Planck energy E_o become simpler and energies more accurate than those obtained from the Planck energy E_{oG} involving G, as if the gravitational constant G were a little off.

$$E_o = 2^{\frac{32+64+128}{3}} \cdot 1.021998\ MeV = 3.064475 \cdot 10^{22}\ MeV \quad (4)$$

$$E_{ep} = \underbrace{2^{-\frac{32+64+128}{3}}}_{\text{Numerator = number of doublings in each degree of freedom}} \cdot E_o = \underbrace{1.0210998\ MeV}_{\text{Accurate by definition}} \quad (5)$$

Method of analysis

Definitions

The Planck energy E_o represents total energy comprising of both the mass-energy and the electromagnetic energy (EM) of the particle. The EM energy has a mass equivalent.

The generalized Planck energy E_{oo} is a scaled up reference energy making it possible to disclose the EM energy of a particle in comparison to the Coulomb energy of the elementary charge.

$$\frac{q_o^{\;2}}{e^2} = 2^{\frac{1+2+4+32}{4}}$$

scale factor

Planck charge:

$$q_o = \sqrt{4\pi\varepsilon_o hc}$$

E_o=3.064475 MeV
E_{oo}=2.638752 MeV

$$E_{ep} = 2^{-\frac{32+64+128}{3}} \cdot E_o \qquad (6)$$

$$E_o \cdot 2^{\frac{1+2+4+32}{4}} = E_{oo}$$

scaling up to new reference energy E_{oo}

$$E_{ep} = 2^{-\frac{32+64+128}{3}} \cdot \underbrace{2^{-\frac{1+2+4+32}{4}} E_{oo}}_{E_o} \qquad (7)$$

1.022 MeV total energy divided into two parts

Method of analysis

The following examples show how the method separates the 3d and 4d parts of the rest energy.

E_{oo} ⇒

$$E_{ep} = 2^{-\frac{32+64+128}{3}} \cdot 2^{-\frac{1+2+4+32}{4}} E_{oo}$$

224 energy halvings from E_o — Coulomb energy indicator

M=39=1+2+4+32 corresponds to the Coulomb energy of the elementary charge. M less than 39 means larger EM energy compared to e^2 (excited EM states).

$$E_p = \pi^{-0.5} \cdot 2^{-\frac{64+64+64}{3}} \cdot 2^{-\frac{1+2+4+32}{4}} E_{oo}$$

For the proton M=39 corresponds to the Coulomb energy of the elementary charge.

$$E_{\Lambda^o} = \pi^{-0.5} \cdot 2^{-\frac{64+64+64}{3}} \cdot 2^{-\frac{1+1+4+32}{4}} E_{oo}$$

M=38 corresponds to the 1’st excited state of the 4d Coulomb energy of the elementary charge. The 3d mass parts of the proton and lambda are equal.

$$E_{\Sigma^o} = \pi^{-1.5} \cdot 2^{-\frac{63+63+63}{3}} \cdot 2^{-\frac{1+2+4+32}{4}} E_{oo}$$

M=39 corresponds to the Coulomb energy of the elementary charge. The 3d mass part is twice that of the proton. Rot-vib mode differs by pi.

$$E_{\Omega^-} = \pi^{-0.5} \cdot 2^{-\frac{64+64+64}{3}} \cdot 2^{-\frac{0+1+4+32}{4}} E_{oo}$$

M=37 corresponds to the 2’nd excited state of the Coulomb energy of the elementary charge. The 3d mass parts of the proton and omega are equal.

particle core

Introduction

We have earlier shown that the proton rest mass is almost fully covered by the superstable core (Lehto 2015). The generalized Planck energy E_{oo} yields:

Proton core from E_{oo}

$$\underbrace{\pi^{-0.5} \cdot \underbrace{2^{-\frac{64+64+64}{3}}}_{\text{3d mass part}} \cdot \underbrace{2^{-\frac{1+2+4+32}{4}}}_{\text{4d Coulomb part}}}_{\text{core}} \cdot E_{oo} = 937.263\ MeV \qquad (8)$$

The 4d part corresponds to the Coulomb energy of the elementary charge (same as an electron).

The natural constants used to calculate the Planck scale reference energy are accurate to at least 5 decimal places [1], which is good enough for our analysis. Equation (8) shows that both the proton (938.272 MeV) and the neutron (939.565 MeV) are a few MeV ’heavier’ than the core given by (8).

In this presentation, we shall try and explain the difference in terms of the 1.022 MeV superstable electron-positron pair structure and its first excited 3d state.

[1] The gravitational constant G is the most inaccurate natural constant (std deviation 47 ppm).

Proton and neutron structures from E_o

Table 1. Proton and neutron using E_{oo} reference.

Eq. (8)	937,263	MeV	Difference	
Proton exp	938,272	MeV	1,009	MeV
Neutron exp	939,565	MeV	2,302	MeV

Added structure	E		Calc Eq.(8)+E	Fit (exp-calc)/exp
ep	1,022	MeV	938,285	-0,0014 %
ep+ep* (3d)	2,310	MeV	939,573	-0,0009 %

$$ep^* = 2^{0.333} \cdot 1.022\ MeV = 1.288\ MeV$$

Table 1 shows that the calculated rest energy of the proton superstable core by Eq.(8) completed by the electron-positron pair yields the measured proton rest energy very accurately. 'Fit' is the relative difference between the measured (exp) and calculated (calc) values.

The neutron requires an additional structure, which is the first excited 3d state of the electron-positron pair denoted by ep*.

We may also note that there is a superstable 3d relation between the proton core (*p*-*ep*) and the ep-pair (*ep*):

$$\frac{p - ep}{ep} \cong 2^{\frac{32}{3}} \cdot \pi^{-0.5} \qquad (9)$$

Proton structure

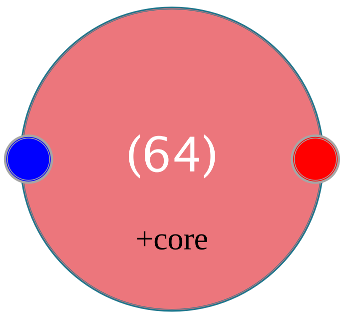


Fig.1. Energetically correct proton structure.

Table 1 shows that the correct proton rest energy is obtained by adding 1.022 MeV to the proton (64)-core.

The required energy corresponds to the rest energy of an electron-positron pair.

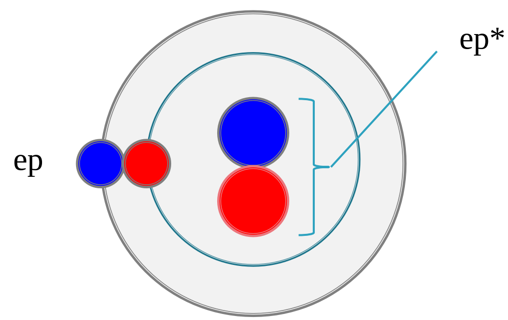
Figure 1 shows the corresponding proton structure schematically.

The blue and red colors indicate negative and positive elementary charge respectively.

The total magnetic moment of the 1.022 MeV pair is zero.

Period 64 is common to the proton core and the ep-pair.

Neutron structure



$$ep^* = 2^{0.333} \cdot 1.022\ MeV = 1.288\ MeV$$

Fig. 2. Neutron structure.

$$2^{0.333} = 2^{\frac{0+0+1}{3}}$$

The neutron is 1.293 MeV 'heavier' than the proton.

Table 1 shows that the first excited 3d state (ep*) of the 1.022 MeV ep-pair has the right energy to explain the difference. The corresponding neutron structure is shown schematically in Figure 2.

Neutron magnetic moment is negative due to the internal charge distribution (negative surface, positive interior).

The neutron is unstable. In the PD scenario, the reason is the decay of the excited ep-pair.

Neutron decay schematically

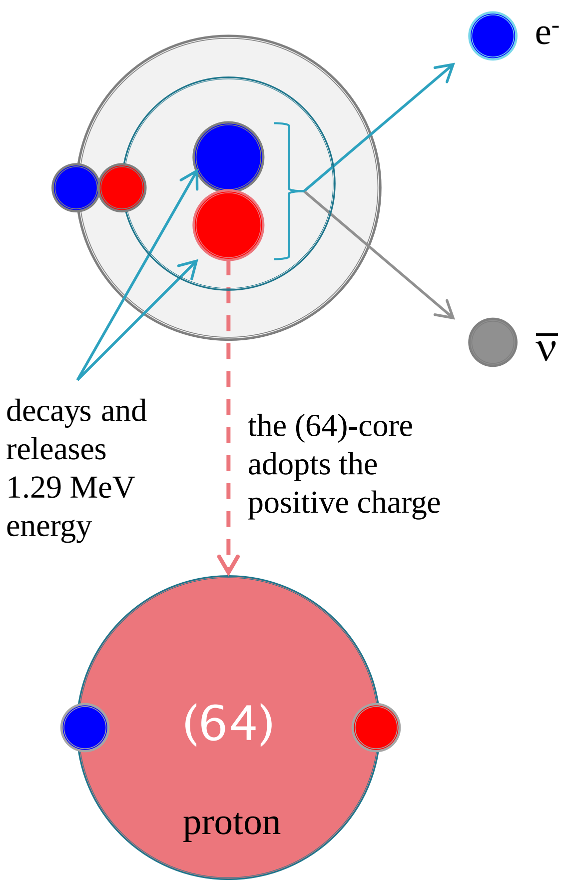


Fig. 3. Neutron decay.

Neutron decay in the PD scenario

The reason for the neutron instability is the decay of the 1.29 MeV excited state ep* of the ep-pair.

The 0.511 MeV (rest energy) electron flies away.

The energy available for the kinetic energy is 1.29 MeV (from the decay) - 0.511 MeV (e^- rest energy) = 0.78 MeV.

The (64)-core adopts the positive charge of the excited pair and becomes the core of the proton (Fig. 3).

Conservation of charge and the total angular momentum demands that a neutral particle is born. The angular momenta of the neutral particle and the electron are equal and opposite. The neutral particle is called neutrino.

In the PD scenario, the neutrino is like a *positron (or an electron) without an electric charge*.

Magnetic moment change

The total change in the magnetic moment is $|\mu_p| - |\mu_n| = (1.4106\cdot10^{-26} - 9.6624\cdot10^{-27})$ Am^2.

$$\frac{\log(4.444\cdot 10^{-27}/\mu_{o-rad})}{\log(2)} = 63.335 \cong \frac{63+63+64}{3} \qquad (10)$$

which belongs to the 3d period doubling sequence.

[2] $\mu_{o\text{-}rad}$ is the Planck scale magnetic moment reference for the nucleons (Lehto 2009, 2015).

Discussion

The Planck energy, based on the rest energy of the electron-positron pair and the Coulomb energy of the Planck charge, yields an energetically accurate description of the internal structures of the proton and the neutron using the period doubling process as an analyzing tool.

It is possible to separate the mass-energy and the EM energy parts from the rest energy of a particle by defining a new Planck energy. Examples are given in slide 7 for a few baryons.

$G = 6.65620 \cdot 10^{-11}$ Nm^2/kg^2 would give the Planck mass corresponding to the exact ep-pair rest energy. The problem is that this value is 0.3 % smaller than the NIST value.

The simple proton structure consists of the superstable (64)-core combined with the 1.022 MeV (32,64,128) superstable ep-pair structure. The neutron structure needs both the 1.022 MeV ep-pair and its 1.29 MeV first excited 3d state. The instability of the neutron can be explained by the decay of the excited state of the ep-pair.

The neutrino cancels the angular momentum of the electron in the neutron decay, otherwise, the total angular momentum is not conserved. In the neutron decay, the charged 0.511 MeV structure is an electron, and we suggest the accompanying uncharged particle is the corresponding neutrino, both of which originate from the decay of the same excited ep-pair.

Discussion

This analysis does not reveal the wavelike nature of the neutrino. An optical vortex is possibly the nearest analog.

The initial neutrino structure is (33,65,129), which is unstable and decays to lower energies. The next superstable low energy structures are (64,128,128) and (64,128,256). The previous one corresponds to the 3K CBR temperature and the latter the Hydrogen 21 cm wavelength.

The total number of period doublings is not unique, except for the superstable periods. For instance, the 1.022 MeV structure corresponds to a total of 224=32+64+128 period doublings. A structure with 224=33+64+127 period doublings has the same energy, but only the 64-period is stable. In general, the degeneracy means that there can exist different internal structures with the same energy.

How about the stability of an electron? In principle, the initial periods after the splitting into two of the ep-pair are (33,65,129). The energy of period 128 is 10^{-10} eV from E_o, and we can think that this is the easiest period for energy fine-tuning. The electron can now obtain a stable periodic structure (32,64,131) by preserving the superstable 32- and 64-periods. The 32-period will then connect the structure to the (1,2,4,32) Coulomb part.

Discussion

In conclusion, the structures of the proton and the neutron, and the decay of the neutron become quite simple and numerically accurate, if the Planck energy used as the reference is defined by the rest energy of the electron-positron pair.

The neutrino comes out in a natural way as the partner of the electron (or positron) in the PD scenario.

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Ari Lehto, several (unpublished) presentations at the Physics Foundations seminars at www.physicsfoundations.org

Thank you!

PTO for appendices

Appendix 1

Data

Electron	0.510999 MeV
Proton	938.272 MeV
Neutron	939.565 MeV
h	$6.626070 \cdot 10^{-34}$ J s
c	299792458 ms^{-1}
G	$6.67408 \cdot 10^{-11}$ Nm^2/kg^2
ε_o	$8.854187 \cdot 10^{-12}$ Fm^{-1}
E_o	$3.06448 \cdot 10^{22}$ MeV
E_{oo}	$2.63875 \cdot 10^{25}$ MeV (includes the periods of the Planck charge Coulomb energy)
E_{oG}	$3.06039 \cdot 10^{22}$ MeV

Notation (64) means $2^{-\frac{64+64+64}{3}}$ (superstable because $64=2^6$).

24.01.2016 http://physics.nist.gov/cuu/Constants/index.html