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Original Research Article

Deducing the proton energy configuration

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ABSTRACT

Articles published prior to 1994 by various authors indicate a mass energy sequence for the pion, muon, and electron in the ratios 4: 3: 2 respectively with increments of about 35.3 MeV, with the electron "rest mass" energy rotationally relativistic at $\alpha^{-1}m_ec^2$, ~ 70 MeV. Considering 35.3 MeV rotationally relativistic by $\alpha^{-2/3}$ (≈ 26.58) extends the sequence to include the proton mass energy at 938 MeV, i.e. 26.58 *x* 35.3 MeV = 938.274 MeV. This observation leads to describing the proton as a single EM wave propagating in a toroidal path with volume contracted by α and thereby exhibiting unit charge in the far field, and evidencing partial charges in the near field consistent with the UUD quarks of the Standard Model. As with quantum chromodynamics (QCD), over 99% of the proton rest mass is relativistic in nature. A value for the proton radius is obtained within the empirical uncertaintys.

Keywords: Proton mass energy, Proton energy configuration, Particle radius, Quantum mass sequence, QCD

INTRODUCTION

Journal articles by several authors, all prior to 1994, show a nominal mass energy sequence for the pion, muon, and electron comprising 4: 3: 2 components respectively.[1 - 6] In summary, The pion and muon have nominal rest mass energies of 140 MeV and 105.7 MeV respectively, and with a relativistic rotational state of α, the fine structure constant ~1/137, the electron rest mass energy (m_ec^2 = 0.511 MeV) indicates an internal rotational energy of $m_ec^2/\alpha \approx 70$ MeV, showing two mass energy increments each of about 35 MeV.

Oakley described the electron as two orthogonal spin-½ electromagnetic (EM) quantum loops rotating about the particle z axis.[7] Each loop energy is $m_ec^2/2\alpha \approx 35.013$ MeV, where loop oscillation out of plane forms a 3D particle and increases this by α, indicating each quantum loop energy m_oc^2, say, is at least

$$m_oc^2 \approx m_ec^2 (1+\alpha)/2\alpha = 35.27 \text{ MeV} \quad (1)$$

The three component muon at 105.66 MeV indicates quantum loop energy of at least

$$m_oc^2 \approx 105.7/3 \text{ MeV} = 35.23 \text{ MeV} \quad (2)$$

These values do not include consideration for other possible minor effects, e.g. binding energy, loop precession, loop cross coupling etc., but their closeness suggests only a slightly greater common quantum energy is likely at about 35.3 MeV.

METHOD

Analytical method

The observable matter in the Universe is mostly composed of two stable elementary particles, electrons and protons. The electron 35 MeV energy quantum is

evidently fundamental to some particles and may relate to the proton. It is thereby informative to compare the proton empirical rest mass energy (m_pc^2 = 938.272 MeV) with 35.3 MeV, i.e.

938.272 MeV / 35.3 MeV = 26.58 (3)

Oakley described the electron as EM (electromagnetic) energy localized in 3D observer space by propagating rectilinearly in highly curved space-time with a relativistic volume increase of α^{-1}.[7] The described particle is in dynamic equilibrium between radial and circumferential metric strains, with circumferential strain the source of gravity and the radial strain projecting directly into observer space as electric field and evident as unit charge. The particle observer space volume is expanded by α^{-1} with the total quantum loop energy propagating in a two dimensional toroidal bound, a "thin shell", nominally decreased by $\alpha^{1/3}$ from $\alpha^{-1}m_ec^2$ (= 70 MeV), to $\alpha^{-2/3}m_ec^2$, where $\alpha^{-2/3}$ = 26.5801, the same numerical value as in (3). Thus essentially the same 35 MeV quantum loop energy is evident in the proton as for the electron, muon and pion by considering;

$\alpha^{2/3}m_pc^2$ = 938.272 / 26.5801 MeV = 35.2998 MeV (4)

It is highly unlikely this is coincidental and implies relativistic effects resulting from energy localization decrease the proton volume by α. This would increase the curvature of the local metric in which the energy propagates, thereby effectively increasing the mass energy in the 2D "shell" by $\alpha^{-2/3}$. The electron and proton relativistic volumes change by α^{-1} and α respectively and the resulting radial metric strains are evident as opposite charges.

The electron is described as a single spin-1 EM wave of 0.511 MeV propagating rectilinearly in a metric of toroidal geometry. A gravitational effect is emergent due to the curved metric and its presence creates the classical impression of a local mass. The energy wavelength wraps α^{-1} turns around the particle z axis while oscillating once along the z axis before repeating the cycle. Thus to a first approximation the electron loop energy is m_ec^2/α about the z axis and m_ec^2along the z axis, nominally totaling $m_ec^2(1+\alpha)\alpha$ at 70.54 MeV, which leads to (1).

Oakley describes the electron energy path as the evolute of a helical toroid.[7] In contrast the proton energy path is posited as the involute of a helical toroid where the energy mainly rotates in a loop and the plane of the loop rotates about and tangent to the z axis, with energy α less than about the x and y axes, and thus traces out a toroid as shown in Figure 1.

The proton volume decrease is posited due to the EM energy becoming spatially localized and relativistic in each of the three observer space dimensions. The observed particle rest mass arises from the space-time curvature radius in which the EM energy propagates and the toroidal propagation path is consistent with the proton exhibiting a magnetic dipole.

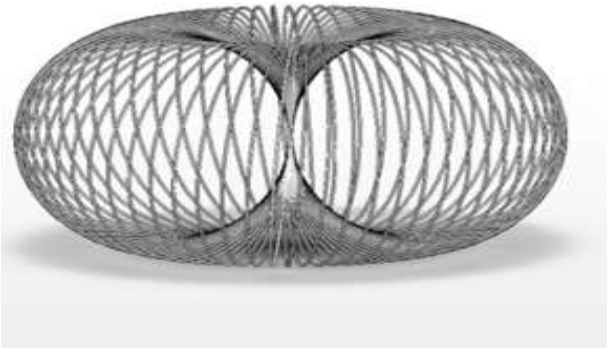

Figure 1: The posited energy path within the proton is the involute of a helical toroid.

The electron relativistic energy circulation about the x and y particle axes is the same but differs from that about the z axis with the product of the three relativistic factors, one about each particle axis, producing the volume change. A similar toroidal energy distribution is posited for the proton where the primary rotation energy is not about the z axis, but about the x and y axes.

By geometry a toroidal volume change of α implies a boundary ("thin shell") area change of $\alpha^{2/3}$. Guided by the Standard Model quark notion, (i.e. a proton consisting of three quarks, up, up, down, UUD, with partial charges 2/3, 2/3, -1/3 respectively), a single basic energy quantum m_qc^2 is posited, where $\alpha^{-1}m_qc^2 \approx m_pc^2$ and energy is distributed about the x, y, z axes as,

$m_qc^2(\alpha^{-2/3}.\alpha^{-2/3}.\alpha^{1/3}) = \alpha^{-1}m_qc^2 \approx m_pc^2$ = 938.272 MeV (5)

Thus (5) gives $m_qc^2 \approx$ 6.84690 MeV and the effective energy about the (x, y, z) axes is (182, 182, 1.33) MeV respectively, with the energy about the z axis α of that about the x and y axes. With EM energy quantized and propagating rectilinearly in toroidal space-time the quantized relativistic energy about each axis relates directly to the space-time curvature about that axis. Note the relativistic loop energy $\alpha^{-1/3}m_qc^2$ = 35.2998 MeV, differs only slightly from the electron value in (1).

A proton basic energy component of 6.8469 MeV is consistent with QCD estimates of over 95% of the proton mass being due to internal relativistic factors. Equation (5) suggests 99.27% of the proton rest mass energy is relativistic by α^{-1} and distributed over three dimensions.

If the basic quantum component is a single EM wave propagating in a toroidal path such that its e-field always points outward, the local radius of curvature will determine the local e-field divergence and the apparent local charge in the near field. As indicated by (5) this will mimic the effect of partial charges in the same ratio the as

for UUD quarks even though only a single EM wave exists. Similarly, energy propagation in a curved path will evidence local 'mass', in the same ratios while propagating rectilinearly in the toroidal curved metric. The proton as a single quantum entity would also explain "quark confinement".

The electron is described as a localized spin-1 EM wave composed of two spin-½ components exhibiting unit charge in the far field via $e^2 = \alpha\hbar c$. If the basic energy quantum within the proton is also of spin ½ it must propagate twice around the particle per cycle along the z axis to mimic a spin-1 EM wave and evidence unit charge. The energy in the rotating frame is thereby $2m_qc^2 = 2\ x\ 6.8469$ MeV = 13.7 MeV, essentially the same as for the electron. I.e. $m_ec^2\,(\alpha^{-2/3}.\alpha^{-2/3}.\alpha^{1/3}) \approx 70$ MeV, where $\alpha^{-2/3}m_ec^2 \approx 13.58$ MeV including the off axis energy increases the total electron energy to 13.68 MeV.

DISCUSSION

Some supporting evidence for the above analysis is provided by considering the implied radius of the proton (r_p), as described. The radius of a 35.3 MeV quantum loop is 5.589 femtometers (fm = 10^{-15}m). If the energy is relativistic and contracted by $\alpha^{-1/3}$ the average radius would be 1.084fm, and a double pass per loop closure distributed over three dimension would effectively reduce the radius by $2^{1/3} = 1.26$, to

$$r_p = 0.8604\text{fm} \qquad (6)$$

This radius value is comparable with empirical data by Pohl, Bernaur, and others.[8-15] Empirical values for the proton radius differ to a much greater extent than the current measurement uncertainty estimates. Bernaur obtained a value of 0.879±0.001 fm, using hydrogen spectroscopy and proton-electron scattering.[8] Pohl evaluated muonic hydrogen energy levels and obtained 0.8409±0.0004 fm.[9,10] The derived proton radius estimate (6) falls nominally halfway between the two empirical values. Additional information on the proton can be found in the literature.[16-19]

CONCLUSION

The proton, electron, muon, and pion all relate to a basic energy of nominally 6.847 MeV in relativistic states of $\alpha^{\pm n/3}$where n is 1, 2, or 3, e.g. $\alpha^{-1/3}6.847$ MeV ≈ 35.3 MeV. If gravity acts via this basic energy m_qc^2 the gravitational constant will be the same for all matter.

The proton concept describes the energy configuration of a particle having the proton mass, with unit charge, and exhibiting a magnetic dipole due to a toroidal energy configuration. It is consistent with the Standard model via the effect of partial charges in the near field, and with QCD, as most of the proton observer space rest mass is of relativistic origin.

Equation (5) and the particle radius calculation suggest a single relativistic energy component propagating and distributed in a toroidal path, a simpler configuration than three individual quarks. This preliminary analysis hopefully provides a basis for a more detailed evaluation of the proton energy configuration. If the proton is indeed a single quantum entity there can be no cross coupling or binding energy and (4) and (5) may be exact expressions.

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