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A Photon-Based Vector Particle Model for Proton and Neutron Masses

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A Photon-Based Vector Particle Model for Proton and Neutron Masses

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Abstract: This work presents a simplified geometric model for the proton-to-electron mass ratio (m_p/m_e), achieving a remarkable precision of seven significant figures ($m_p/m_e \approx 1836.1521964$, relative error -2.6×10^{-7}) matching CODATA's 1836.15267343. Building on T.N. Lockyer's *Vector Particle Physics* (2000), the model eliminates an ad hoc QED-inspired correction, improving precision from six to seven significant figures in double-precision arithmetic. Rounding errors do not allow us to verify whether this model predicts a better outcome. The neutron-to-electron mass ratio ($m_n/m_e \approx 1838.68982960$, error 3.35×10^{-6}) achieves six significant figures, consistent with the model's structure.

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1. Introduction

Quantum Chromodynamics (QCD) describes nucleon masses via quark-gluon interactions, but its computational complexity motivates alternative models to explore underlying principles. Thomas N. Lockyer's *Vector Particle Physics* [1] proposes that nucleons are lepton-based, with mass arising from photon momentum stored in spinning, nested square layers rotated by 45°. This paper formalizes the model, verifies its high-precision predictions for m_p/m_e and m_n/m_e, and discusses its potential to illuminate symmetries in the Standard Model.

2. Model Description

The proton is modeled as a positron (mass m_e, charge $+e$) forming a base level (level 0), with 18 energy layers (levels 1–18). Each layer is an idealized square with side length tied to the rationalized Compton wavelength ($\lambda_e' = \hbar/(m_e c) \approx 3.8615932 \times 10^{-13}$ m). The inner square, rotated 45°, has corners at the midpoints of the outer square's sides, yielding a $\sqrt{2}$ scaling:

$$L_{\text{inner}} = \frac{L_{\text{outer}}}{\sqrt{2}}. \tag{1}$$

The neutron adds an electron (mass m_e, charge $-e$) sharing level 0 and doubles level 1 for binding energy. Rest mass arises from photon momentum ($p = h/\lambda$) confined in spinning layers, with energy contributions:

$$m = \frac{e^2}{m_e 4\pi c^2 \lambda_e' d\epsilon_0}, \quad d = \frac{1 - \sqrt{2}/2}{2} - \frac{a_u}{\sqrt{2}}, \quad a_u = 2\left(\sqrt{1 + \frac{\alpha}{2\pi}} - 1\right). \tag{2}$$

Mass contributions per level i (1 to 19) are:

$$m_1[i] = \frac{(\sqrt{2})^{i-1}}{1 - \sqrt{2}a_u}, \quad m_2[i] = m \cdot \frac{(\sqrt{2})^{i-1}}{1 - \sqrt{2}a_u}. \tag{3}$$

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3. Calculations

The proton mass ratio is:

$$m_p/m_e = \sum_{i=1}^{19}(m_1[i] + m_2[i]). \tag{4}$$

The neutron mass ratio includes doubled first two levels:

$$m_n/m_e = \sum_{i=1}^{19}(m_1[i] + m_2[i]) + \sum_{i=1}^{2}(m_1[i] + m_2[i]). \tag{5}$$

Implementation details are in Appendix G.

4. Results and Discussion

The JavaScript implementation yields:

- Proton: $m_p/m_e = 1836.1521964$, error -2.6×10^{-7} vs. CODATA's 1836.15267343 (seven significant figures).
- Neutron: $m_n/m_e = 1838.6898296$, error 3.35×10^{-6} vs. CODATA's 1838.68366173 (six significant figures).

_-_ Calculation of the proton/electron mass ratio _-_

Level	m1	m2	m1+m2	Sum
1	1.000000	0.050110	1.050110	1.050110
2	1.416540	0.070983	1.487523	2.537633
3	2.003289	0.100386	2.103675	4.641308
4	2.833079	0.141967	2.975046	7.616354
5	4.006579	0.200771	4.207350	11.823704
6	5.666158	0.283933	5.950091	17.773795
7	8.013158	0.401542	8.414700	26.188495
8	11.332316	0.567867	11.900183	38.088678
9	16.026315	0.803085	16.829400	54.918078
10	22.664632	1.135733	23.800365	78.718443
11	32.052631	1.606169	33.658800	112.377243
12	45.329265	2.271466	47.600731	159.977974
13	64.105261	3.212338	67.317599	227.295573
14	90.658530	4.542932	95.201462	322.497035
15	128.210522	6.424676	134.635199	457.132234
16	181.317059	9.085864	190.402924	647.535157
17	256.421045	12.849353	269.270397	916.805554
18	362.634119	18.171729	380.805848	1297.611402
19	512.842089	25.698705	538.540794	1836.152196

Calculated proton/electron mass ratio : 1836.15219639
--- Official proton/electron mass ratio : 1836.15267343 (CODATA 2020)
Relative error = -2.60e-7 = -0.00000026 = -0.000026%

Calculated neutron/electron mass ratio : 1838.68982960
--- Official neutron/electron mass ratio : 1838.683662 (CODATA 2020)
Relative error = 3.35e-6 = 0.00000335 = 0.000335%

Figure 1. Output of the JavaScript code, showing mass contributions per level.

Note: The total mass contribution of each row $(m_1[i] + m_2[i])$ is exactly equal to the total of the previous multiplied by $\sqrt{2}$, reflecting the geometric scaling of the nested square layers rotated by 45°.

The model's precision, using only fundamental constants and a $\sqrt{2}$ factor from 45°-rotated square geometry, suggests a physical basis. The photon momentum stored in spinning layers offers a lepton-centric alternative to QCD. The 19 levels may reflect an energy quantization (∼52 MeV per layer) related to cosmological conditions.

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The model's inclusion of an electron-like contribution in the first layer of the neutron raises the possibility of exploring connections to the strong force that binds nucleons, though such an extension requires further theoretical development.

5. Implications and Future Work

Lockyer's model challenges QCD by prioritizing photon-based electromagnetic interactions. Its precision suggests a semi-classical approximation of strong force effects or a new symmetry. Future work could:

- Derive the 19-level energy condition.
- Model the spinning-photon mechanism as charge loops.
- Attempt to further improve accuracy with CODATA constants.
- Extend the model to derive the masses of the muon and tauon, adapting the summation framework to account for their mass ratios.

6. Conclusions

QCD no longer needs to prove its computational capabilities. Lockyer's photon-based model, with no reference to quarks, raises questions and invites us to try to understand and possibly reconcile the two approaches.

Appendix A. JavaScript Implementation

The following code calculates m_p/m_e and m_n/m_e:

```
// Fundamental physical constants (CODATA 2020)
// Light speed (m/s)
const lightSpeed = 299792458;
// fine structure constant - dimensionless
const fineStructureConstant = 0.00729735257
const pi = Math.PI;
// Magnetic vacuum permeability
// (Henry per meter : H/m  [N/A^2])
const vacuumPermeability = 4*pi / Math.pow(10,7);
// vacuum permittivity (8.8541878176 * 10^-12 F/m)
const vacuumPermittivity = 1 / (lightSpeed * lightSpeed * vacuumPermeability);
// electron charge (A*s)
const electronCharge = 1.602176634 * Math.pow(10,-19);
// Compton wave length  (m)
const comptonWavelength = 2.4263102367 * Math.pow(10,-12);
// rationalized Compton wavelength electron (m)
const rationalizedComptonWavelength = comptonWavelength/(2*pi);
// electron mass (kg)
const electronMass = 9.1093837015 * Math.pow(10,-31);
// Relative electron mass;
const relativeElectronMass = 1;
const sqrt2 = Math.sqrt(2);
const codataProton = 1836.15267343;
const codataNeutron = 1838.683662;

// Rationalized fine structure constant
const rationalizedFineStructure = fineStructureConstant/(2*pi);
const scalingfactor = 2 * (Math.sqrt(1 + rationalizedFineStructure) - 1);
// The radius of each level is slightly smaller
const layerSpacing = (1-(sqrt2/2))/2 - scalingfactor/sqrt2;
var scallingContribution = Math.pow(electronCharge,2)/(electronMass * 4 * pi *
    Math.pow(lightSpeed,2) * rationalizedComptonWavelength * layerSpacing *
    vacuumPermittivity);

document.write ("<table>");
```

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```
document.write ("<th colspan=5 style='text-align:center;'>_-_   Calculation of the proton/electron mass ratio   _-_ </th>");
document.write ("<tr><td>Level</td><td>m1</td><td>m2</td><td>m1+m2</td><td>Sum</td></tr>");

var m1 = new Array(); var m2 = new Array();
m1[1] = relativeElectronMass; m2[1] = scallingContribution;
var totalMass=0;
const denominator = 1-sqrt2*scalingfactor;

// Execute calculations and displays
for(i=1;i<=19;i++){
    m1[i+1]= relativeElectronMass * Math.pow(sqrt2,i) / denominator;
    m2[i+1]= scallingContribution * Math.pow(sqrt2,i) / denominator;
    totalMass += m1[i] + m2[i];
    document.write ("<tr><td>" + i + "</td><td>" +
    m1[i].toFixed(6) + "</td><td>" +
    m2[i].toFixed(6) + "</td><td>" +
    eval(m1[i]+m2[i]).toFixed(6) + "</td><td>" +
    totalMass.toFixed(6) + "</td></tr>");
}
document.write ("</table>");

document.write ("<br>Calculated proton/electron mass ratio : "+ totalMass.toFixed(8)+ " <br>--- Official proton/electron mass ratio : 1836.15267343  (CODATA 2020)");
mr = eval((totalMass-codataProton)/codataProton);
document.write ("<br>Relative error = " + Number.parseFloat(mr).toExponential(2) + " = " + mr.toFixed(8)+ " = " + (100*mr).toFixed(6) + "%");

// Neutron mass is given by proton mass + two first layers mass
document.write ("<br><br>Calculated neutron/electron mass ratio : "+ (totalMass+m1[1]+m2[1]+m1[2]+m2[2]).toFixed(8) + "<br>--- Official neutron/electron mass ratio : 1838.683662  (CODATA 2020)");
mr = eval((totalMass+m1[1]+m2[1]+m1[2]+m2[2]-codataNeutron)/codataNeutron);
document.write ("<br>Relative error = " + Number.parseFloat(mr).toExponential(2) + " = " + mr.toFixed(8) + " = " + (100*mr).toFixed(6) + "%");
```

References

1. T. N. Lockyer, *Vector Particle and Nuclear Models*, TNL Press, 2000, ISBN: 0963154680.
2. CODATA, Recommended Values of Fundamental Physical Constants, 2020.