Exact calculation of the Fine Structure Constant sets the lepton and quark masses

Brian Dale Nelson

ABSTRACT

In 2014, the Fine Structure Constant (FSC) was calculated to be 137.035999209569 [1], and in 2020, a refined measurement landed within one standard error at 137.035999206(11) [2] suggesting this calculated value is accurate. The hypothesis behind this calculation claims bonded particles absorb precise quantities of force carrier energy to share common factor energy quanta between their adjusted Compton wavelengths. Subsequent analysis presented in this paper provides additional evidence suggesting the FSC, lepton masses, quark masses, and their coupling constant energies are all interdependent and their precise values, all within current CODATA measured values, are set by these shared common factor quanta.

HYPOTHESIS

The origin of the Fine Structure Constant remains one of the greatest mysteries in modern physics. Any valid attempt to unravel this mystery must address the fundamental question. Why does an electron share such a precise amount of photon energy to bond with a proton? One plausible answer is so that it can share a much larger quanta of energy.

Figure 1. Sharing of Common Factor Quanta

Figure 1 shows an electron sharing a photon with the proton as defined in the Standard Model. The Compton wavelengths of electron and proton shorten slightly with the addition of the shared photon energy. At an exact photon energy value, the electron and proton share common factors.
between these adjusted Compton wavelengths. Whether these common wavelengths interlace to form standing waves, or they allow virtual particles to be shared is open to interpretation. For this analysis, the shared wavelengths will be referred to as common factor quanta.

**PROTON-ELECTRON MODEL**

To search for common factors between wavelengths, all masses and energies were converted to long integers. A common factor search is exact, and dimensionless. The reciprocal of the Fine Structure Constant is proportional to the ratio of photon energy to the electron energy as shown in Equation (1):

\[
\frac{1}{\alpha} = \frac{1}{\sqrt{\frac{2\lambda_{\text{electron}}}{\lambda_{\text{photon}}}}}
\]

Based on Plank’s Law, there is an inversely proportional relationship between a particle’s wavelength and its energy. Given the integer energy of the photon is \( n_v \) and the integer mass energy of the electron is \( n_{me} \) the equation may be updated to Equation (2).

\[
\frac{1}{\alpha} = \frac{1}{\sqrt{\frac{2n_v}{n_{me}}}}
\]

**Figure 2. Electron-Proton Common Factor Quanta**

Figure 2 shows a shared quanta diagram between the electron and proton. By sharing a photon with an exact integer mass energy of 3717 (shown in yellow), the electron \((n_{me} + n_v) = 139602083 + 3717\) and proton \((n_{mp} + n_v) = 256330738058 + 3717\) integer energies share a common factor of 295775, about 80X the energy of the photon. The Fine Structure Constant may be calculated using Equation (3):

\[
137.035999209569 = \frac{1}{\sqrt{\frac{2 + 3717}{139602083}}} \]

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(3) \[ 137.035999209569 = \frac{1}{\sqrt{2 \times 3717 \times 139602083}} \]

These integers are multiples of 59, and may be further simplified to Equation (4):

(4) \[ 137.035999209569 = \frac{1}{\sqrt{2 \times 63 \times 2366137}} \]

This common factor analysis not only sets the value of the Fine Structure Constant, it also sets the exact values of the electron and proton masses. These masses can be converted into more recognizable MeV units through a conversion factor shown in Equation (5). This is a simple ratio of the proton integer mass \( n_{mp} \) and the 2018 CODATA value of the proton mass in MeV. The integer values are exact, the MeV values are approximate since they involve measurement error.

(5) \[ \text{Conversion Factor} = \frac{256330738058}{938.27208816} \]

**ELECTRON-UUD QUARK MODEL**

![Electron-UUD Quark Model Diagram](image)

Using the exact same values for the FSC, photon, electron, and proton mass/energy integer values shown above, another large quanta was found to be shared between the electron and the Up-Up-Down quarks in the proton as shown in Figure 3. In this case, the shared common factor quanta equals the entire electron energy (electron mass + photon), which is the maximum possible value of a shared quanta between these bonded particles. By sharing a photon with an exact integer mass energy of 3717 (shown in yellow), the electron \((n_{me} + n_{\nu}) = 139602083 + 3717\) and UUD quarks \((n_{mued} + n_{\nu}) = 2373294883 + 3717\) integer energies share a common factor of \(139605800\). This analysis also sets the Up quark mass at \(55544135\) (2.0335117 MeV), and the Down quark mass at \(1262206613\) (4.62017643 MeV).
The analysis was extended to the gluon-quark bonds within the proton and neutron as shown in Figure 3. At the proton mass integer value \(256330738058\) set by the calculated FSC \((137.035999209569)\), another massive common factor quanta was discovered between the up and down quarks. The common factor quanta is equal to the difference in mass between the proton and neutron, and common to both particles. The common factor quanta is also equal to \(2\times\) the difference in mass between the down and up quark. In the proton, by sharing a gluon with an exact integer energy of \(253842947945\) (shown in orange), the up quark \((n_{mu} + n_{vp}) = 555544135 + 253842947945\) and down quark \((n_{md} + n_{vp}) = 1262206613 + 253842947945\) integer energies share a common factor of \(353331239\) (1.29333236MeV). In the neutron, by sharing a gluon with an exact integer energy of \(254196279184\) (shown in green), the up quark \((n_{mu} + n_{vp}) = 555544135 + 254196279184\) and down quark \((n_{md} + n_{vp}) = 1262206613 + 254196279184\) integer energies also share a common factor of \(353331239\) (1.29333236MeV).

**Figure 3. Proton-Neutron Quark Common Factor Quanta**
The muon and tau leptons also share large common factor quanta with the electron as shown in Figure 4. The electron mass integer value (139602083) and photon energy (3717) remain set by the calculated FSC (137.035999209569). As in the case of the uud quarks, the shared common factor quanta between the tau and electron equals the entire electron energy (electron mass + photon), which again, is the maximum possible value of a shared quanta between these bonded particles. In the tau, by sharing a photon with an exact integer energy of 3717 (shown in yellow), the electron \( (n_{me} + n_p) = 139602083 + 3717 \) and tau \( (n_{mt} + n_p) = 485409362883 + 3717 \) integer energies share a common factor of 139605800 (0.00327572 MeV). In the muon, by sharing a photon with an exact integer energy of 3717 (shown in yellow), the electron \( (n_{me} + n_p) = 139602083 + 3717 \) and muon \( (n_{mm} + n_p) = 28865285251 + 3717 \) integer energies share a common factor of 894909 (0.00327572 MeV).

**UNCERTAINTY IN SOME CALCULATED CONSTANTS**

The common factor analysis used to calculate constants is exact without uncertainties for a given sets of constants. However, multiple sets of constants do add uncertainty in the case of the proton and neutron analysis because there are too many variables to pin down certain constants to exact values. However, these uncertainties are very small, and the predictions of constants with variability remain very precise. The uncertainty ranges shown in Table 2 depend on the search range used for acceptable neutron masses, a +/- 3 uncertainty range was used for the 2018 CODATA neutron mass. As additional shared quanta are discovered (e.g. top, down, charm, strange quarks), these uncertainties will likely converge to a single, exact solution for all of the lepton and quark constants. Several of the calculated constants remain exact with no uncertainty in their integer values as shown in Table 1.
Table 1. Calculated Constants with Exact Integer Values

<table>
<thead>
<tr>
<th></th>
<th>Exact Integer Value</th>
<th>MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Structure Constant</td>
<td>137.035999209569</td>
<td>n/a</td>
</tr>
<tr>
<td>Photon Energy</td>
<td>3717</td>
<td>0.0000136057</td>
</tr>
<tr>
<td>Electron Energy</td>
<td>139602083</td>
<td>0.5109989497</td>
</tr>
<tr>
<td>Proton Energy</td>
<td>256330738058</td>
<td>938.27208816</td>
</tr>
<tr>
<td>Up-Up-Down Quark Quanta</td>
<td>139605800</td>
<td>0.5110125554</td>
</tr>
</tbody>
</table>

Table 2. Uncertainties in Calculated Constants with Variability

<table>
<thead>
<tr>
<th></th>
<th>Min Value</th>
<th>Max Value</th>
<th>Min MeV</th>
<th>Max MeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up Quark Mass</td>
<td>555543885</td>
<td>555544377</td>
<td>2.03351079</td>
<td>2.03351259</td>
</tr>
<tr>
<td>Dn Quark Mass</td>
<td>1262206129</td>
<td>1262207113</td>
<td>4.62017466</td>
<td>4.62017826</td>
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<tr>
<td>Neutron Mass</td>
<td>256684068934</td>
<td>256684069672</td>
<td>939.56541920</td>
<td>939.56542190</td>
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<tr>
<td>Proton Gluon</td>
<td>253842686343</td>
<td>253843218195</td>
<td>929.16483284</td>
<td>929.16677963</td>
</tr>
<tr>
<td>Neutron Gluon</td>
<td>254196017219</td>
<td>254196549809</td>
<td>930.45816387</td>
<td>930.46011336</td>
</tr>
<tr>
<td>Proton Quanta</td>
<td>353330876</td>
<td>353331614</td>
<td>1.29333104</td>
<td>1.29333374</td>
</tr>
</tbody>
</table>

SEARCH FOR ADDITIONAL FINE STRUCTURE CONSTANT CANDIDATES

Search Parameters:
- 2020 Fine Structure Constant: 137.035999209569
- Uncertainty Value (+/-): 0.000000011
- 1000 Uncertainty Range (+/-): 0.000011
- Starting Search Value: 137.035988206
- Ending Search Value: 137.036010206

Figure 5. Search for other Fine Structure Constant Candidates
Figure 5 shows the results of a +/-1000 uncertainty search for other Fine Structure Constant candidates that provide the same or higher common factor quanta found in this analysis including:

1) Electron multiple of 472 or less in the bond with a proton
2) Electron-up-up-down quark multiple of 1
3) Proton-quark gluon multiples where the quanta = difference in neutron proton mass
4) Electron-tau multiples of 1

Only one candidate was found, the 2014 calculated value of 137.035999209569. Considering 2000 (+/-1000) possible uncertainty ranges, that’s a 1/2000 chance or a greater than 99.95% probability this particular FSC is the correct value.

DISCUSSION

In 2014 when the FSC exact value 137.035999209569[1] was first calculated, it was only based on a 472 electron multiple shared with the proton and the multiples calculated for tau and the muon. When the 2020 FSC was measured at 137.035999206(11) [2], and it converged to within one standard error of this calculated value, it provided validation this value was correct. But the most compelling evidence is this value’s ability to set so many other fundamental constants in the Standard Model. Each new constant calculated adds additional evidence including the newly discovered maximum possible common factor quanta between the electron and the uud proton quarks, and the maximum possible common factor quanta between quarks and gluons in the proton and neutron. Each new piece of the puzzle adds further proof this analysis speaks to a foundational law regarding bonded particles and their energy values. Each fundamental constant is interdependent and are all calculated together from a simple relationship defined by the Fine Structure Constant.

My hope is that this hypothesis and its promising results will be vetted, expanded upon, and accepted by the scientific community to help further our understanding of the origin of these constants.

REFERENCES
