4. Unifying the Fine Structure Constant Definitions

I first define a new empirical origin for the proportionality constant of Coulomb’s law:

\[ f_\xi = \frac{qq}{4\pi\varepsilon r^2} \] (1)

The magnitude of the previously introduced fundamental increment of time is the same as the magnitude of electric charge. The units of inverse acceleration for mass leads, with reason, to replacing electric charge with this increment of time [6]:

\[ f_\xi = \frac{\Delta t_c \Delta t_c}{4\pi\varepsilon r^2} \] (2)

The results being provided here are intended to demonstrate that this substitution is justified. Force is generally defined as:

\[ f = \frac{\Delta E_K}{\Delta x} \] (3)

For this example, the distance involved is the radius of the hydrogen atom. Adding subscripts and setting the equations equal to one another:

\[ \frac{\Delta E_x}{\Delta x} = \frac{\Delta t_c \Delta t_c}{4\pi\varepsilon \Delta x^2} \] (4)

The subscript \( K \) denotes kinetic energy and, the subscript \( c \) denotes properties pertaining to the hydrogen atom and the electromagnetic properties that hold it together. Solving for permittivity:

\[ \varepsilon = \frac{\Delta t^2_c}{4\pi E_k \Delta x} = \frac{\Delta t_c}{4\pi E_k \frac{\Delta x}{\Delta t_c}} = \frac{\Delta t_c}{4\pi E_k C} \] (5)

Multiplying by unity:
\[ \varepsilon = \left( \frac{\Delta x_c}{\Delta x_c} \right) \left( \frac{\Delta t_c}{4\pi E_K C^2} \right) = \frac{\Delta x_c}{4\pi E_K C^2} \]  

Yielding:

\[ \varepsilon = \frac{1}{4\pi} \frac{E_K}{C^2} \left( \frac{\Delta x_c}{\varepsilon} \right) = \frac{1}{4\pi} \frac{f_{\xi H1} C^2}{\varepsilon} \]  

(7)

The subscript \( n_1 \) represents the first energy level of the hydrogen atom. The proportionality constant of Coulomb’s law is:

\[ k = \frac{1}{4\pi \varepsilon} \]  

(8)

Substituting for \( \varepsilon \):

\[ k = \frac{1}{4\pi} \frac{1}{\frac{1}{4\pi} f_{\xi H1} C^2} = f_{\xi H1} C^2 \]  

(9)

The formal expression for the fine structure constant contains constants from electromagnetic theory, relativity theory, and quantum theory. It is important to know the empirical basis for it. I replace \( C \) with the variable speed of light \( v_c \).

\[ \alpha = \frac{2\pi \varepsilon}{h C} = \frac{2\pi}{h v_c} \]  

(10)

I use Planck’s constant as it would normally be used. For the rest I substitute the expressions from this new work for the constants in the equation. The subscript \( c \) denotes a measurement that involves electromagnetism. The expression derived for the proportionality constant ‘\( k \)’ from Coulomb’s Law is, from equation (44):

\[ k = f_{\xi H1} C^2 = \frac{E_K}{\Delta x_c} C^2 = \frac{E_K}{\Delta x_c} \frac{\Delta x_c^2}{\Delta t_c^2} = E_K \frac{\Delta x_c}{\Delta t_c^2} \]  

(11)
For the next step, electric charge will again be replaced with $\Delta t_c$, the fundamental increment of time.

Polarity is not included:

$$e = \Delta t_c$$

(12)

Therefore, from the numerator of the expression, equation (45), defining the fine structure constant:

$$k e^2 = E_K \frac{\Delta x_c}{\Delta t_c} \Delta t_c^2 = E_K \Delta x_c$$

(13)

My expression for the speed of light is:

$$v_c = \frac{\Delta x_c}{\Delta t_c}$$

(14)

Where, $\Delta x_c$ is the radius of the hydrogen atom. The normal use of Planck’s constant $h$ is:

$$h = \frac{E_K c}{\omega}$$

(15)

Substituting these identities into the equation for the fine structure constant, its empirical meaning is:

$$\alpha = \frac{2\pi k e^2}{h C} = \frac{2\pi k e^2}{hv_c} = \frac{2\pi E_K \Delta x_c}{\omega \Delta t_c} = 2\pi \omega \Delta t_c$$

(16)

When the frequency $\omega$ is solved for, it calculates closely to that of the hydrogen atom’s electron. The fine structure constant appears to be the angle, in radians, the electron travels during the fundamental increment of time. The fine structure constant is also equivalent to the ratio of the speed of the electron in the first energy level of the hydrogen atom to the speed of light:
The incremental distance in the numerator is that traveled by the hydrogen electron during the time it takes for light to travel the radius. The incremental distance in the denominator is the radius of the hydrogen atom:

\[
\alpha = \frac{\Delta x_p}{\Delta x_e} = \frac{\Delta x_p}{\Delta t_c} = \frac{\Delta x_p}{\Delta t_c} \tag{17}
\]

The time required for light to travel the radius of the hydrogen atom is:

\[
\Delta t_c = \frac{\Delta x_e}{C} = \frac{4.8 \times 10^{-11} \text{ meters}}{2.998 \times 10^8 \text{ meters/second}} = 1.602 \times 10^{-19} \text{ seconds} \tag{19}
\]

The time it takes for the electron to travel one radian is:

\[
\Delta t_p = \frac{\Delta t_c}{\alpha} = 137 \Delta t_c = \frac{1}{2\pi \omega} \tag{20}
\]

Where ‘\(\omega\)’ is the electron’s orbital frequency (see the explanation that follows equation (51)). Solving for alpha:

\[
\alpha = 2\pi \omega \Delta t_c \tag{21}
\]

Yielding the previous solution, equation (51). The two fine structure constant expressions are derivable one from the other.