Exponential Formula for the Fine Structure Constant

Rodolfo A. Frino – February 2015 (v1)
Electronics Engineer
Degree from the National University of Mar del Plata

Abstract

This paper introduces a new exponential formula for the fine-structure constant. This approximate formula is expressed in terms of the masses of the electron, the neutron and the proton. The error of the formula is less than 1%. This accuracy suggests that there is an unknown parameter which has not been taken into account.

Keywords*: fine-structure constant, mass ratio, NIST.*

1. The Formula

The exponential formula for the fine-structure constant is

$$\alpha \approx 2^{-18\rho} \tag{2.1}$$

where ρ is defined as the ratio

$$\rho \equiv \frac{m_e}{m_n - m_p} \tag{2.2}$$

where

$\alpha =$ fine-structure constant
$\rho =$ mass ratio
$m_e =$ electron rest mass
$m_n =$ neutron rest mass
$m_p =$ proton rest mass

Combining equations (2.1) and (2.2) yields

$$\alpha \approx 2^{-18\left(\frac{m_e}{m_n - m_p}\right)} \tag{2.3}$$

The value of the fine-structure constant given by this formula is

$$\alpha \approx 0.007\,229\,708\,17$$

The value given by NIST (2010) is

$$\alpha_{NIST\,2010} \approx 0.007\,297\,352\,569\,8\,(24) \approx 0.007\,297\,352\,57$$

The absolute error is

$$\alpha_{NIST\ 2010} - \alpha \approx 0.007\ 297\ 352\ 57 - 0.007\ 229\ 708\ 17 \approx 0.000\ 067\ 644$$

The relative error is

$$\text{Relative Error} = \frac{\alpha_{NIST\ 2010} - \alpha}{\alpha_{NIST\ 2010}} \approx \frac{0.000\ 067\ 644}{0.007\ 297\ 352\ 57} \approx 0.009\ 269\ 718$$

The relative error as a percentage is

$$\text{Relative Error (\%)} = \frac{\alpha_{NIST\ 2010} - \alpha}{\alpha_{NIST\ 2010}} \times 100 \approx 0.93\,\%$$

Thus, the relative error is less than 1 %

2. Conclusions

The value yielded by the formula suggests that there is a "fine tuning parameter" which has not been taken into account. If this unknown parameter exists, it would make the formula even more accurate.

REFERENCES

[1] NIST, *Fundamental Physical Constants—Extensive Listing*, retrieved 2011 from: http: //physics.nist.gov/constants, (2010)