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

\[ \alpha \approx 2^{-18 \rho} \]  

(2.1)

where \( \rho \) is defined as the ratio

\[ \rho \equiv \frac{m_e}{m_n - m_p} \]  

(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

\[ \alpha \approx 2^{-18 \left( \frac{m_e}{m_n - m_p} \right)} \]  

(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

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

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

The relative error as a percentage is

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

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