Formula For The Fine-Structure Constant Based On The Number Pi

In this paper I introduce a formula for the fine-structure constant based on the number pi. The formula improves the accuracy of a previous similar formula by 4 decimal places, so that, the accuracy of the new formula is 10 decimal places.

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1. Introduction

In a previous article [1] I introduced the following formula for the fine-structure constant

$$\alpha = \frac{2^{10} - 10^3}{(\pi + 3)2^{10} - 3 \times 10^3} \tag{1.1}$$

This formula is accurate to 6 decimal places. In this article I present a new formula that improves the accuracy of formula (1.1) by 4 decimal places. Thus, the accuracy of the new formula is 10 decimal places. The improvement yielded by the new formula will be achieved by adding a correction factor to the numerator.

2. The Formula

A correction factor given by

$$\frac{1}{3 \times 360} \tag{2.1}$$

is added to the numerator of formula (1.1). This yields the new formula for the fine-structure constant

Form 1

$$\alpha = \frac{2^{10} - 10^3 + \dfrac{1}{3 \times 360}}{(\pi + 3)2^{10} - 3 \times 10^3} \tag{2.2}$$

The value this formula yields has been calculated with a hand held calculator and is

$$\alpha \approx 0.007\ 297\ 352\ 53 \tag{R1}$$

The measured value for the fine-structure constant published by NIST [2] in 2010 is

$$\alpha_{NIST\ 2010} \approx 0.007\ 297\ 352\ 569\ 8(24) \tag{R2}$$

The numbers in parenthesis indicate the uncertainty in the last two decimal places of the measured value. Comparing the result (R1) of formula (2.2) with the corresponding CODATA value (R2), and without rounding off the measured value, we find that the accuracy of the new formula is 10 decimal places.

3. Other Ways of Writing the Formula

Two other forms of expressing formula (2.2) are

Form 2

$$\alpha = \frac{24 + \dfrac{1}{1080}}{1024 \times \left(\pi + 3 - \dfrac{375}{128} \right)} \tag{3.1}$$

Form 3

$$\alpha = \frac{1 - \dfrac{125}{128} + \dfrac{1}{1080 \times 1024}}{\pi + 3 - \dfrac{375}{128}} \tag{3.2}$$

4. Conclusions

The formula presented here was derived from a previous formula by adding a correction factor to the numerator. However, we could have subtracted a different correction factor to the denominator, and in doing so we would have found a different formula. As the reader might have guessed, this proves that the new formula of the fine-structure based on an improved version of formula (1.1) is not unique (by the way, we may have improved formula (1.1) in many other ways).

It is worthwhile to remark that form 1 is more "illustrative" that the other two alternative forms since it shows more clearly that the formula depends not only on the number pi but also on a power of 2 and on a power of 10. It is also important to observe that the number 3 plays three different roles in the formula: firstly, the role of an exponent (10^3), secondly, the role of a factor (3×10^3) and (3×360); and lastly, the role of a term added to the number pi $(\pi + 3)$.

REFERENCES

[1] R. A. Frino, *The Role of Powers of 2 in Physics*, viXra.org: viXra 1507.0047, (2015).
[2] NIST, *Fundamental Physical Constants—Extensive Listing*, retrieved from: http: //physics.nist.gov/constants, (2010).