On Feynman's Speculations About the Origin of the Fine-Structure Constant

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Abstract: When thinking about the origin of the fine-structure constant, renowned physicist Richard Feynman speculated that it might be related to pi or the base of the natural logarithm. However, he could not envision how pi or the natural logarithm's base could be associated with the constant. This article presents an equation that helps to address Feynman's question.

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When thinking about the origin of the fine-structure constant (the electromagnetic coupling constant), renowned physicist Richard Feynman stated the following:

> "All good theoretical physicists put this number up on their wall and worry about it…you would like to know where this number for a coupling comes from: is it related to pi or perhaps to the base of natural logarithms? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man."[1]

An equation producing the value of the constant to an approximation actually can be established using pi and the base of the natural logarithm:

$$\alpha \approx \frac{1}{16\pi e} \tag{1}$$

where e is the base of the natural logarithm at approximately 2.718.

The equation produces a value close to the accepted value of the fine-structure constant, at approximately 1/137. Missing is a factor in the denominator of about 1.0030. This is similar to the square of the factor leading to the anomalous magnetic moment of the electron at about $(1.0012)^2$ or 1.0024. Considering that electric and magnetic phenomena are often linked, this suggests that indeed a similar anomalous factor might be needed in the above equation to attain the full value of the fine-structure constant:

$$\alpha \approx \frac{1}{16\pi e \ (anomalous\ factor)} \tag{2}$$

As the anomalous factor of the electron's magnetic moment is attainable through quantum mechanics, future analyses might identify a quantum mechanical basis to the possible anomalous factor needed in equation (2).

Although the equation does not identify the origin of the fine-structure constant, it does answer at least the second half of Feynman's question, stated in the quote above — that the fine-structure constant is, or at least might be, related to pi and the base of the natural logarithm, to an approximation. With this knowledge and further investigation, particularly perhaps a quantum mechanical perspective on the above, the actual origin of the fine-structure constant may eventually be uncovered, fully answering Feynman's question.

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[1] Feynman RP. QED: The Strange Theory of Light and Matter. Princeton University Press. 1985, p 129.

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