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Speculation on the Number 137 in the Fine-Structure Constant

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Abstract

The fine-structure constant (α) is a fundamental physical constant, *i.e*. the coupling constant characterizing the strength of the electromagnetic interaction. It is important to know why 1/α is approximately equal to the number 137, because this mysterious number very likely forms the link between three very important domains of physics: quantum mechanics, electromagnetism, and relativity. Since the Pythagorean prime number137 equals 4 squared plus 11 squared, it is here speculated that 1/α = 137 perhaps in some mysterious way reflects fundamental properties, for instance the 4 dimensions of Einstein's space-time and the 11 dimensions of M-theory. Also, the number 4 might be related to the four forces, *i.e*. the electromagnetic force, the gravitational force and the strong and weak nuclear forces, or perhaps to another 4 and 11 combination of fundamental constants.

Keywords: Fine-structure constant - 137

1.The Fine Structure Constant

The concept of fine-structure constant (*Feinbaukonstante*) was introduced in the early 1910s by Arnold Sommerfeld in order to explain the spectral lines of hydrogen atom radiation, *i.e.* the fine structure of the hydrogen spectrum. In physics, this constant, usually denoted by α, the small Greek letter alpha, being a dimensionless quantity, has a constant numerical value in all systems of units. The commonly used abbreviated expression in physics literature is $\alpha = e^2/\hbar c$, where e is the elementary charge, ħ is the reduced Planck constant, and c is the speed of light in vacuum. The CODATA recommended value of 1/α is 137.035 999 139(31) (NIST, 2014). This number represents the probability that an electron will absorb a photon, but it has even more significance in the fact that it relates three very important domains of physics, *i.e.* quantum mechanics in the form of Planck's constant, electromagnetism in the form of the charge of the electron, and relativity in the form of the speed of light. Since the early 1900's physicists have suspected that this number might be at the heart of a grand theory that would unify quantum mechanics, electromagnetism , and relativity, although such a theory, provisionally named Grand Unified Theory or GUT has yet to be developed.

2. The Number 137

For many years the number 137 for the reverse value of α has intrigued physicists. In 1938 Arthur Eddington proposed a relation with the number of protons in the observable universe, but this assumption later turned out to be wrong (Eddington, 1956). Nevertheless, Eddington's premise that the number 137 in α should refer to a measurement that would be itself be dimensionless, seems logical. Later, Richard Feynman referred to the number 137 in the fine-structure constant as follows: '… It has been a mystery ever since it was discovered more than fifty years ago, and all good theoretical physicists put this number up on their wall and worry about it. Immediately you would like to know where this number for a coupling comes from: is it related to π or perhaps to the base of natural logarithms? Nobody knows. It's one of the greatest mysteries of physics: a magic number that comes to us with no understanding by man…' (Feynman, 1985).

Stable matter, and therefore life and intelligent beings could not exist if the value of α = 1/137 were much different. For example, were α to change by 4 per cent, stellar fusion would not produce carbon, so that carbon-based life would be impossible. If α were larger than 0.1, stellar fusion would be impossible and no place in the universe would be warm enough for life as we know it (Barrow, 2001).

3. Speculation

The 137 number in the fine-structure constant is dimensionless, so if it is equal in value to something fundamental in nature, that 'something' should be dimensionless too. This was already implicit in Eddington's

assumption. That 137 is the sum of 4 squared plus 11 squared could perhaps mean that here the number 4 refers to the number of dimensions of Einstein's space-time, and 11 to the number of dimensions required by M- theory (these 11 include the 4 of space-time plus 7 assumed curled up cosmological dimensions). Alternatively, the number 4 might refer to the four forces, i.e. the weak and strong nuclear forces, the electromagnetic force, and the gravitational force. To continue this thought further, universes in a multi-universe bubble might only be possible if their $1/\alpha$ equals Pythagorean primes, in other words there can only be universes with $1/\alpha$ values of about 5, 13, 17, 29, etc.

It should be pointed out that all this is mere speculation based on the fact that 137 is a Pythagorean prime number, and that Pythagorean primes equal the sums of two squares. Furthermore, no explanation is given for the fact that $1/\alpha$ deviates from 137 by about 0.036 (NIST, 2014). Also, it is possible that the fine-structure constant changes with time or distance, and so would not be a fundamental constant at all. On the other hand, the above may be an idea to work on, because if the fine-structure constant could be derived from string theory, this would be a rigorous test for that theory.

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