Where number 137 comes from in the integer portion of the Fine Structure constant reciprocal and how to get constant's precise value?

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Abstract

Physicists should admit: the Fine Structure constant continues to attract attention of scientific community mostly because of constant's unexplainable numerical value. Its unbreakable "code" is a real magnet for publications. The challenge is to provide a physical interpretation of the constant with mathematical results matching the number.

Some scientists call attempts to calculate the value of the constant "a numerology" because they are satisfied with experimental results for the constant and/or do not need an explanation for the value itself. Scientific magazines politely reject manuscripts dedicated to a derivation of the Fine Structure constant on grounds of limited space (in journals). Nevertheless…

Looking at the reciprocal of the Fine Structure constant value of **137.035999…** measured with great precision (one part per 3 billion) it is unfeasible to make an immediate statement where those numbers come from. Even integer portion **137** of the constant very likely does not have any analogy in objects or parameters of 4-dimensional world we know.

But by switching to an assumption that there are extra spatial dimensions in our continuum it is relatively simpler to generate a basis for rationalization of different physical phenomena including the source of the Fine Structure constant's value. Author believes that space itself and specifically number of dimensions are the keys for the deciphering of the Fine Structure constant.

One popular hypothesis [1] tells that there are extra 7 curved at small scale dimensions which we cannot sense directly because dimensions are bent with a radius about the size of an atom. These 7 dimensions exist in addition to 3 dimensions we can feel. Total of 10 spatial dimensions is accompanied by the 11-th dimension – the Time.

Using this differentiation of spatial dimensions (**10** dimensions contain **7** dimensions which diverse from the remaining **3** dimensions) author has noticed that a boundary of 10-dimentional hypercube contains $\mathbf{2^{10-7} \cdot \binom{10}{7} = 960}$ of 7-dimensional cubes while the decremented value 960-1 = 959 is multiple of **137**.

The article presents detailed explanation for number **137** in the reciprocal of the Fine Structure constant value based on properties of 10-dimensional hypercube. For short, the origin of **137** can be traced to 10-dimensional configuration of space and summarized in expression (1) as follows:

$$\mathbf{137 = \frac{959}{7}} \qquad \mathbf{(1)}$$

where

$$\mathbf{959 = 960 - 1 = 2^{10-7} \cdot \binom{10}{7} - 1 = 2^{10-7} \cdot \frac{10!}{7!\,(10-7)!} - 1}$$

- $\mathbf{960}$ - is the number of 7-dimensional cubes in 10-dimensional hypercube boundary;
- $\boldsymbol{7}$ - represents the number of small (curved) spatial dimensions;
- 10 - represents the total number of spatial dimensions.

Author also suggests expression (2) for calculation of precise value for the Fine Structure constant reciprocal using the same numbers from 10 dimensional hypercube as parameters:

$$\mathbf{137.035999032 = \frac{\frac{959}{7}}{\sqrt{1 - \frac{\pi^2}{u-1}}}\ , \boldsymbol{where}\ \boldsymbol{u} = \frac{959}{7} \cdot \frac{960}{7}} \qquad \mathbf{(2)}$$

The result of the expression (2) resides in the boundaries of 2010 CODATA recommended value for the Fine Structure constant.

Another precise formula (3) contains only integer numbers as parameters

$$\frac{\mathbf{1}}{\mathbf{137.035999040}} = \boldsymbol{\beta} \cdot \frac{\mathbf{7}}{\mathbf{959}} + (\mathbf{1} - \boldsymbol{\beta}) \cdot \frac{\mathbf{7}}{\mathbf{960}} \qquad (\mathbf{3})$$

where

$\boldsymbol{\beta} = \frac{\mathbf{3}}{\mathbf{4}} - \frac{\mathbf{3}}{\mathbf{10 \cdot 137}}$ is the probability for scenario with 959 cells involved;

$\mathbf{1} - \boldsymbol{\beta} = \frac{\mathbf{1}}{\mathbf{4}} + \frac{\mathbf{3}}{\mathbf{10 \cdot 137}}$ is the probability for scenario with 960 cells involved.

Detailed Explanation

The Fine Structure constant is defined as a ratio of the electrostatic energy between two electrons at a distance **d** and energy of photon with the same wavelength **d**.

Considering that we also can inversely tell that the Fine Structure constant is the ratio of the distance **d** between two charged particles and wavelength **D** of photon having the same energy as charged particles at the distance **d**. But photons are generated by charged particles when particles change speed. The question is why in experiments **d** is "seen" as **D** which is **≈137** times longer?

Author's explanation suggests that the process of this magnification might be similar to cinema's principle: small image from a film is projected to a big screen and thus expanded. In case of the Fine Structure constant, a charged particle is a projector and screen is hypercube of 10 dimensions representing spatial dimensions in our continuum.

One property of any super cube is recurrence of its boundary implying that the boundary can be composed of cubes of smaller dimensions.

To illustrate the border of hypercube let's consider 3-dimensional cube (regular cube). Its boundary is formed by 6 sides of squares, while squares are actually 2-dimensional cubes. Each square in turn has own boundary which consists of 4 line segments or 1-dimensional cubes. Using similar steps but in opposite direction we can compose n-dimensional hyper cube consisting of m-dimensional cubes.

In general, the number of **m**-dimensional hyper cubes on the border of **n**-dimensional hypercube is determined by formula (derived by simple recurrence counting)

$$\boldsymbol{E_{m,n} = 2^{n-m} \cdot \binom{n}{m} = 2^{n-m} \cdot \frac{n!}{m!\,(n-m)!}} \qquad \mathbf{(4)}$$

In the abstract author has promised to explain a way of getting number 137 (associated with integer portion of the Fine Structure constant reciprocal) from properties of 10-dimensional hypercube. The choice of 10 is dictated by total number of spatial dimensions which is hypothetically 10 = 3 + 7. We definitely observe 3 spatial dimensions unless our senses lie to us. Remaining 7 spatial dimensions must be different from 3 "normal" spatial dimensions. Otherwise we would recognize and sense all 10 of them without differentiation. It could be a case these 7 dimensions are too tiny for humans to feel. Nevertheless, diversity of spatial dimensions should be detectable in physical phenomena especially at distances smaller than Bohr radius. And the value of the Fine Structure constant is a solid confirmation for the hypothesis which is limited so far by considering a co-existence of 7 extra dimensions in addition to our good old 3 dimensions.

To elaborate that idea, let staff numbers 10 and 7 in formula (4) to get a count of 7-dimensional hyper cubes on the boundary of 10-cube

$$E_{7,10} = 960 \qquad (5)$$

Fig. 1 presents an illustration for boundary of 10-dimensional cube. It consists of 960 7-dimensional cubes.

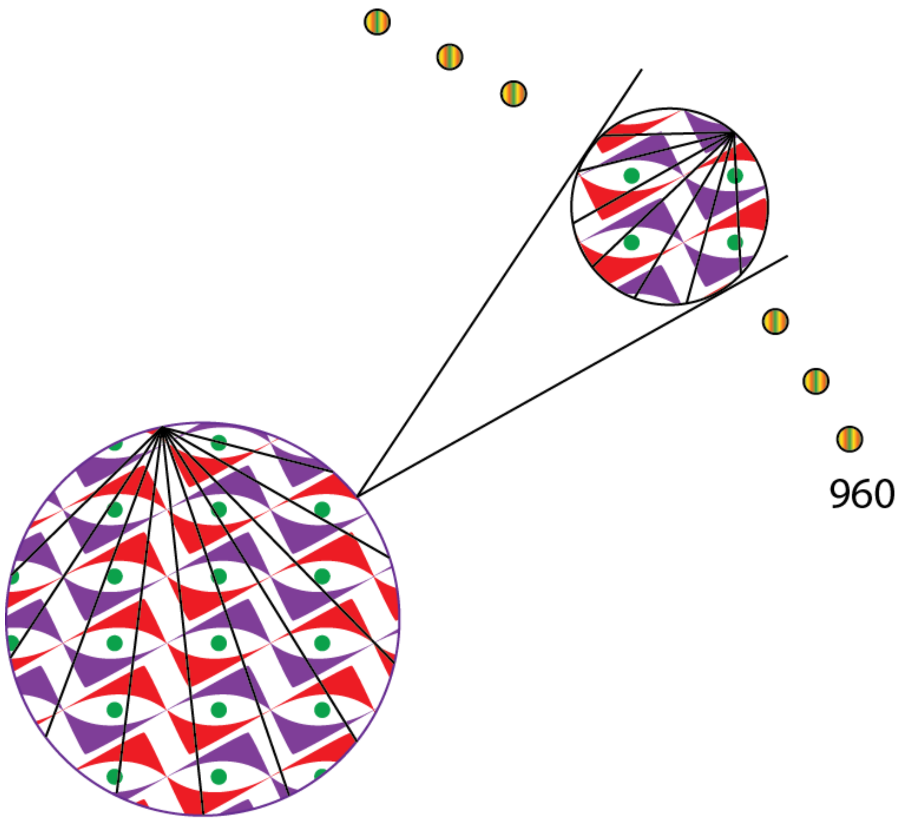

Fig.1 A 10 dimensional cube consists of 960 7-dimensional cubes

Assume that a charged particle happened to be in one of 960 of 7-dimensional cells and this particle emits a photon. Due to its wave nature photon is distributed (projected) on all other cells (960-1=959) with the exception of originating one. Respectively, 959 cells are forming a screen and originating cell is performing a role of a projector.

On the other hand, photon is a corpuscle and prefers to move along straight line and cannot stay. A strait line (edge of the hypercube) is shared by seven adjacent 7-dimensional cubes.

Combining the above considerations into ratio (6) we are deriving an integer portion of the Fine Structure constant.

$$\mathbf{137} = \frac{\mathbf{960-1}}{\mathbf{7}} = \frac{\boldsymbol{E_{7,10}} - \mathbf{1}}{\mathbf{7}} \qquad (6)$$

How to get a precise value for the Fine Structure constant?

Describing method of projection on 959 7-dimensinal cells author has excluded the originating cell (projector) from being part of the screen. In reality, projector can illuminate itself. If photon is distributed on all 960 7-cubes the ratio gives next zoom coefficient of 960/7 = 137.14…

If there are two projection's scenarios (one with zoom ratio 959/7=137 and another with zoom ratio 960/7=137.14…) it should be a probability distribution between them.

The known from experiments value of the Fine Structure constant is positioned in between these two limits 137 and 137.14… but not in the middle. Experimental value corresponds to approximately 75% chance for 959 cells illumination by wave function of photon and 25% chance for all 960 cells illumination.

More precisely,

$$\frac{\mathbf{1}}{\mathbf{137.035999040}} = \boldsymbol{\beta} \cdot \frac{\mathbf{7}}{\mathbf{959}} + (\mathbf{1} - \boldsymbol{\beta}) \cdot \frac{\mathbf{7}}{\mathbf{960}} \qquad (3)$$

where

$\boldsymbol{\beta} = \frac{\mathbf{3}}{\mathbf{4}} - \frac{\mathbf{3}}{\mathbf{10 \cdot 137}}$ is the probability for scenario with 959 cells involved;

$\mathbf{1} - \boldsymbol{\beta} = \frac{\mathbf{1}}{\mathbf{4}} + \frac{\mathbf{3}}{\mathbf{10 \cdot 137}}$ is the probability for scenario with 960 cells involved.

Expression (3) produces the result precisely located in the limits for the 2010 CODATA recommended value for the Fine structure constant.

There is a different form of representation for the Fine Structure constant which has been given in the abstract's expression (2) and repeated here. The result (2) is similar (superficially) to a relativistic mass correction for a particle moving at approximately **π/137** of speed of light.

$$\mathbf{137.035999032} = \frac{\frac{959}{7}}{\sqrt{1-\frac{\pi^2}{u-1}}}, \textit{where } u = \frac{959}{7}\cdot\frac{960}{7} \qquad (2)$$

Expression (2) has been found by reconstruction of the value of the Fine Structure constant using Taylor series. The result also precisely fits the boundaries for the 2010 CODATA recommended value for the Fine structure constant.

It is significant that formula (2) contains only one hypothetical term which is **7** as the number of extra spatial dimensions. Number **7** produces number **10** as the total number of spatial dimensions (**7** invisible dimensions plus **3** dimensions human can sense).

Number **960** is a count of **7** dimensional cells in **10** dimensional hypercube. Number **959** is decremented version of **960**.

And finally, **π** appears in expression (2) due to the fact that the nature does not "like" sharp edges in objects and always tries to make a sphere from a cube.

References

1. Duff, Michael J., M-Theory (the Theory Formerly Known as Strings), International Journal of Modern Physics A, 11 (1996) 5623–5642, online at Cornell University's arXiv ePrint server