Clarifying the origin of the fine-structure constant

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1. Overview

The fine-structure constant is generally considered to be a coupling constant that represents the strength of the electromagnetic interaction of elementary particles, but its origin is unknown. Using the electron and proton model of energy body theory, I clarified the origin of the fine-structure constant from the relationship between Coulomb's law and Planck's constant.

2. Derivation

2.1 Fine structure constant

The fine structure constant is:

$$\alpha = \frac{\mu_0 c e^2}{2h} = \frac{e^2}{4\pi\varepsilon_0 \hbar c}$$

The fine structure constant was introduced by Sommerfeld in 1916 to explain the fine structure that appears in the spectral lines of hydrogen-like atoms. It is now considered to be a coupling constant that describes the strength of electromagnetic interactions between elementary particles in a more general sense, independent of atomic structure. However, it has not been known why this value appears.

2.2. Abstract

The electron and proton model of energy body theory has revealed that the fine structure constant is a different expression that applies to the same phenomenon, in which Coulomb's law and the Planck constant apply.

In other words, the energy applied by Coulomb's law and the Planck constant are equal. The energy of these two different expressions was combined in an equation and transformed to derive the fine structure constant. The derived equation also showed that the fine structure constant is the ratio of the distance between the bound electron and proton to the wavelength of light. The wavelength of light is 137 times longer than the distance between the electron and proton. This is because the wavelength of light is expressed by the following equation.

Wavelength of light = electron transition distance + photon speed (= electron transition speed approx. 2,000 km/sec) v × time required for excitation t

Note: For the difference between the speed of the photon and the speed of light, see 3.

2.3. Formula

The origin (derivation) of the fine structure constant is as follows:

Coulomb's law is as follows (1).

$$f = k_0 \frac{e^2}{r^2} \quad (1)$$

Here, since $k_0 = 10^{-7}c^2$, (1) becomes (2).

$$f = 10^{-7}c^2 \cdot \frac{e^2}{r^2} \quad (2)$$

Transforming (2) gives us (3).

$$2\pi rf = \frac{2\pi \times 10^{-7} ce \times ce}{r} \quad (3)$$

Therefore, the restoration energy E_k of the foots of the electron and proton due to their interaction is given by (4) below.

$$E_k = \frac{2\pi \times 10^{-7} ce \times ce}{r} \quad (4)$$

The energy E_p at the bonding point of an electron and a proton is given by (5) using the equation for Planck's constant.

$$E_p = h\nu = h\frac{c}{\lambda} \quad (5)$$

Since E_k and E_p are the same, (4) and (5) become the following (6).

$$\frac{2\pi \times 10^{-7} ce \times ce}{r} = h\frac{c}{\lambda} \quad (6)$$

Rearranging (6) gives (7).

$$\frac{2\pi \times 10^{-7} ce \times ce}{hc} = \frac{r}{\lambda} \quad (7)$$

Here, $\mu_0 = 4\pi 10^{-7}$, $\therefore 10^{-7} = \frac{\mu_0}{4\pi}$, so multiplying both sides of (7) by 2 gives us (8).

$$\frac{2\pi\mu_0 \times ce \times ce}{4\pi hc} = \frac{r}{\lambda} \quad (8)$$

Here, $\frac{2\pi}{h} = \frac{1}{\hbar}$ $\quad \frac{1}{\mu_0\varepsilon_0} = c^2$, then

$$\therefore \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{r}{\lambda} \quad (9)$$

2.4. Concept

Figure 1 explains that the energy to which Coulomb's law applies is equal to the energy to which the formula for the Planck constant applies.

To understand this figure, you need to know the elementary particle model of the Energy Body Theory, so a simple explanation has been added to term 3.

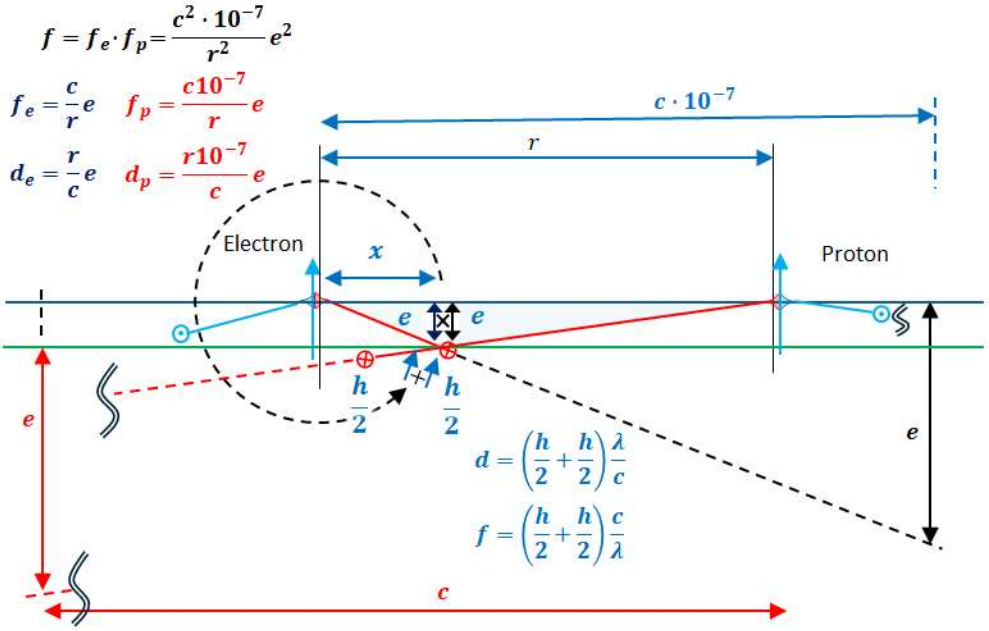
An electron and a proton have disklike shapes rotating as wave and widely spreading. When the foot of each waves comes into contact, both feet are distorted and restoring forces are generated. Depending on the direction of each waves at the contact point, if they are the same, it is an attractive force, and if they are different, it is a repulsive force.

Coulomb's law expresses the restoring force from the distortion of the electron's foot and the distortion of the proton's foot by multiplying both electric charges.

The equation for Planck's constant expresses the restoring force from the distortion of the electron's wave foot and the distortion of the proton's wave foot by adding both functions like angular momentum.

However, although the energy to which Coulomb's law applies is equal to the energy to which the formula for the Planck constant applies, there are some points to note. Planck's constant is the raw value of one electron and one proton, whereas Coulomb's law is a coarse-grained approximation of many, many electrons and protons, but when viewed as one electron and one proton, quantum mechanics and electromagnetism have the same value.

Diagram showing Coulomb's law and the equality of energy of electronic transitions(frequency condition)



The distortion of the foots of an electron and a proton
Planck's constant captures it in terms of angular motion h.
Coulomb's constant captures it in terms of attractive and repulsive forces $\pm e$.

Photon (Kinetic energy of electron)wavelength

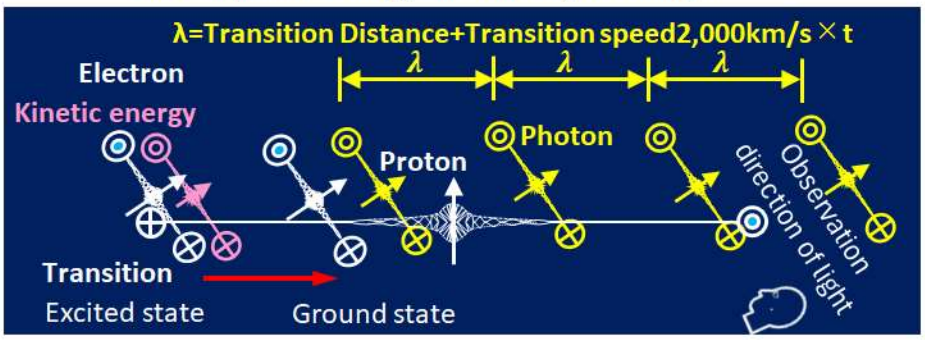


Fig1

3. Particle model of energy body theory

3.1. Overview

First, let me briefly explain what the elementary particle model based on the energy body theory is. The elementary particle model of the energy body theory is a locally excited state of space. In the energy body theory, it is considered that space is made up of energy cell bodies

of the Planck length. The restoring force when energy cell bodies expand, or contract is the source of energy. In other words, if one energy cell body contracts, the adjacent energy cell body will expand, and overall equilibrium is maintained. When the energy cell bodies receive pressure from all directions of the celestial sphere, they contract to the limit. However, if the pressure is greater than this, the energy has nowhere to go and starts to rotate. On the other hand, the energy cell bodies that have contracted to the limit expand because the pressure is deflected. In this way, the pressure that was moving toward the center is instantly converted into rotational energy, so the expansion and contraction rotate as vibrations. It is important to note here that the entire elementary particle that is formed does not rotate around like a top. This rotation of energy appears as the crests and troughs of a wave like wrinkles extending radially from the center, and the phase shifts in the direction of rotation. This rotation of the wave is a de Broglie wave. This is the cause of the spin of elementary particles. Due to the balance with this gravitational field and their own spin, elementary particles such as electrons and protons can continue to exist.

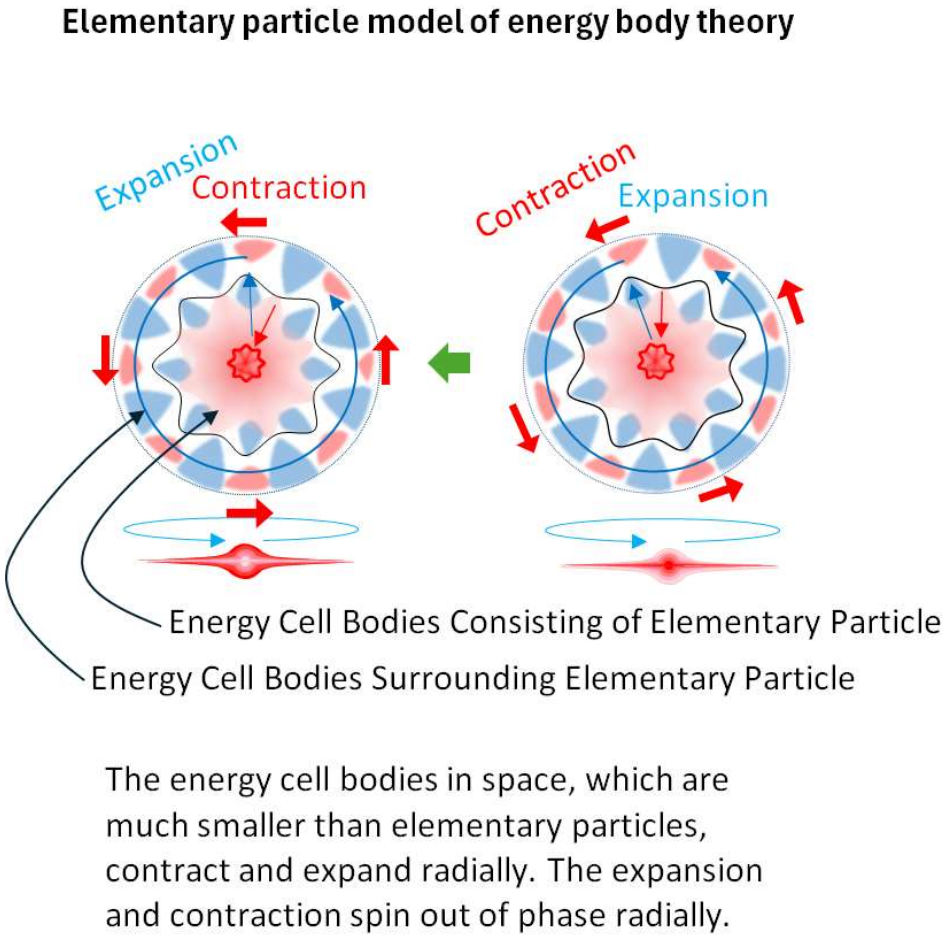


Fig.2

Elementary particles have a disk-like shape with the foot that spreads out into space. The particle in the center represents a particle, and the foot represents a field.

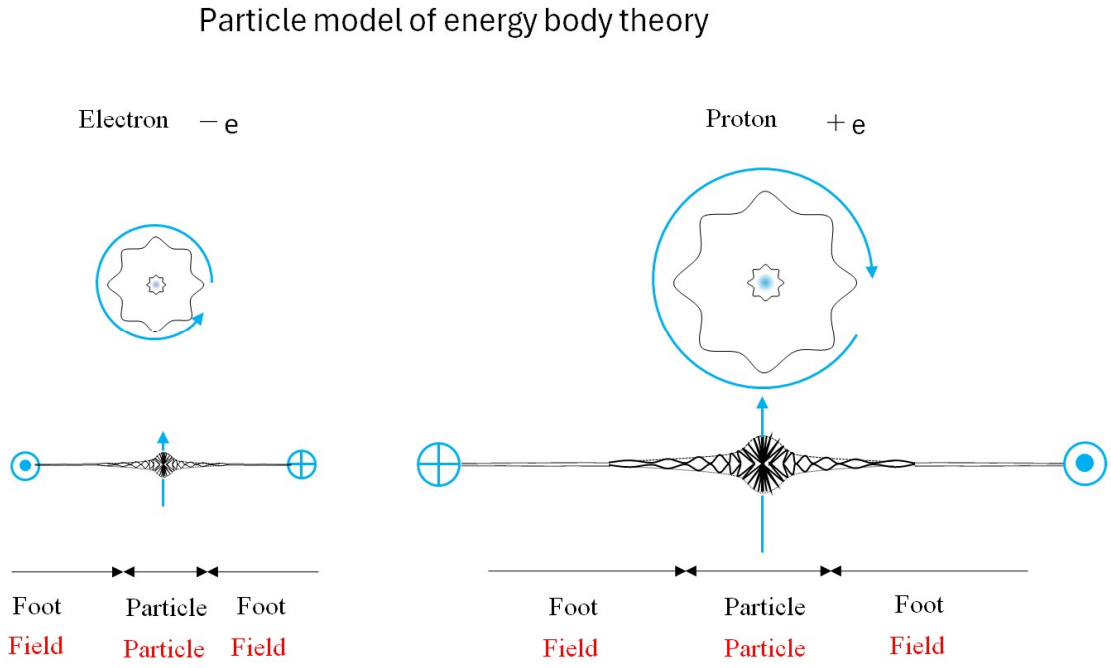


Fig.3

3.2. Electromagnetic Interaction

Electromagnetic interaction depends on the direction of the waves at the interaction; when the waves are in the same direction, an attractive force occurs, and when the waves are in opposite directions, a repulsive force occurs.

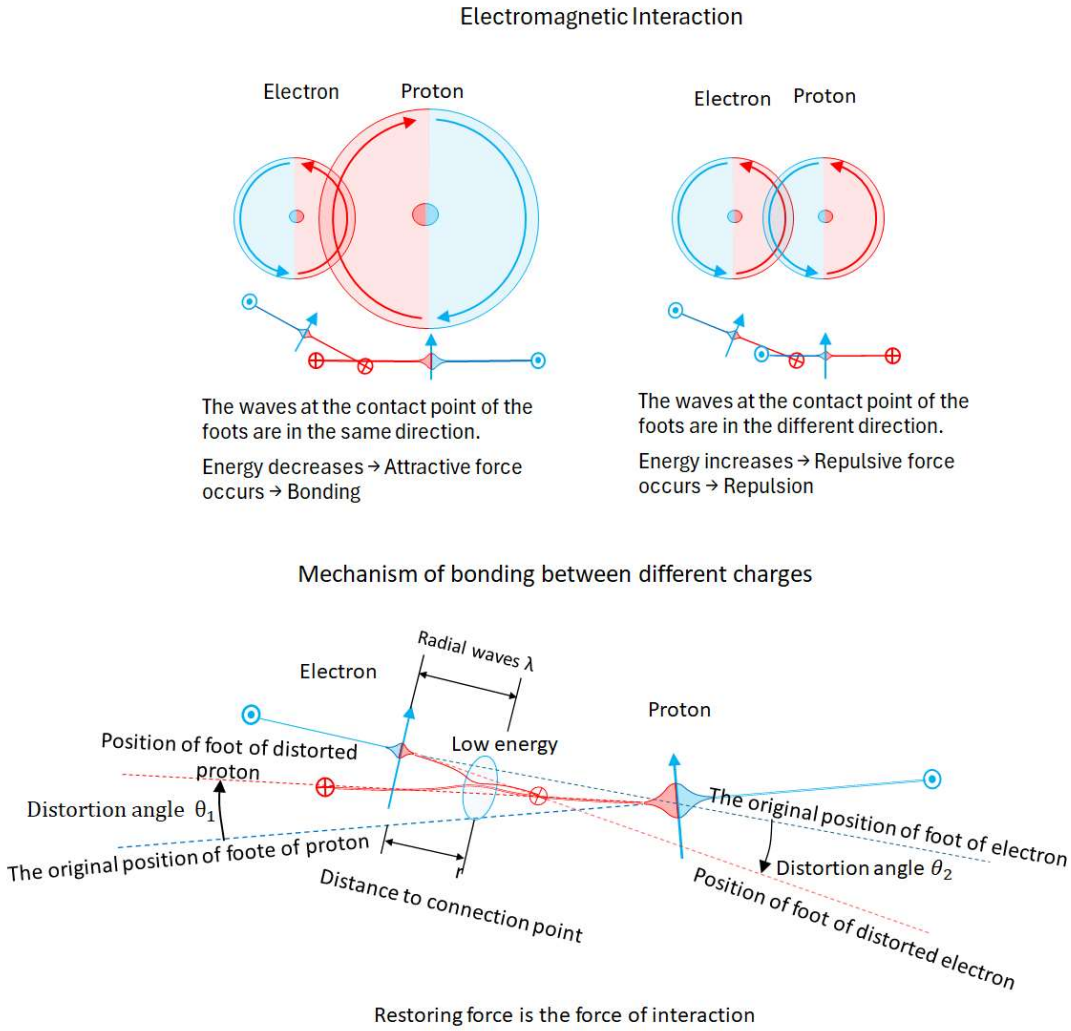


Fig.4

3.3. Derivation

Coulomb's law and Planck's constant are the same thing as the restoring energy of the distortion of the foot of the rotating waves of electrons and protons, expressed from different perspectives.

Coulomb's law regards the energy decrease (or increase) caused by the wave directions of electrons or protons as an attractive or repulsive force $\pm e$.

In the space where an electron and a proton come into contact, the directions of the rotating waves of the electron and proton are the same. This increases the rotation speed and decreases the energy of the space at the contact point. As a result, restoring energy generates, and they attract each other. When the waves are opposite to each other, energy increases, and they

repulsive each other.

Planck's constant regards the restoring direction of the distortion of the rotating waves caused by the wave directions of electrons or protons as angular motion h.

In the space where an electron and a proton come into contact, the directions of the rotating waves of the electron and proton are the same.
As a result, the rotation speed increases, and the wavelength of the rotating wave (de Broglie wave) extends.
Then, the foot of the rotating wave is distorted at an angle θ, and the energy of the space at the contact point decreases.
As a result, restoring energy generates and angular momentum 1/2 h comes into effect.
In other words, the restoring energy of Coulomb's law and the restoring energy of Planck's law are the same. By connecting these two laws with an equation, we can derive the fine structure constant α, which connects Coulomb's law of electromagnetism and Planck's law of quantum mechanics.

3.4. Photon generation

The electron on the proton orbit is bound to the proton in the position as shown in Figure 5. At this time, the foot of the rotating wave of the electron and proton is distorted. Coulomb's law applies. When an electron in a ground state orbit moves to an excited state orbit and exceeds the excitation limit, kinetic energy is generated in front of the electron. At the same time, the excited state of the proton is released, and the electron transitions to the ground state orbit. When the electron stops in the ground state orbit, the distortion in the foot ~~base~~ of the electron's rotating wave is released, and the kinetic energy is emitted as a photon. The release of the distortion (excitation) in the foot of the electron and proton and the generation of kinetic energy is the electron transition energy, and the Plan constant applies.

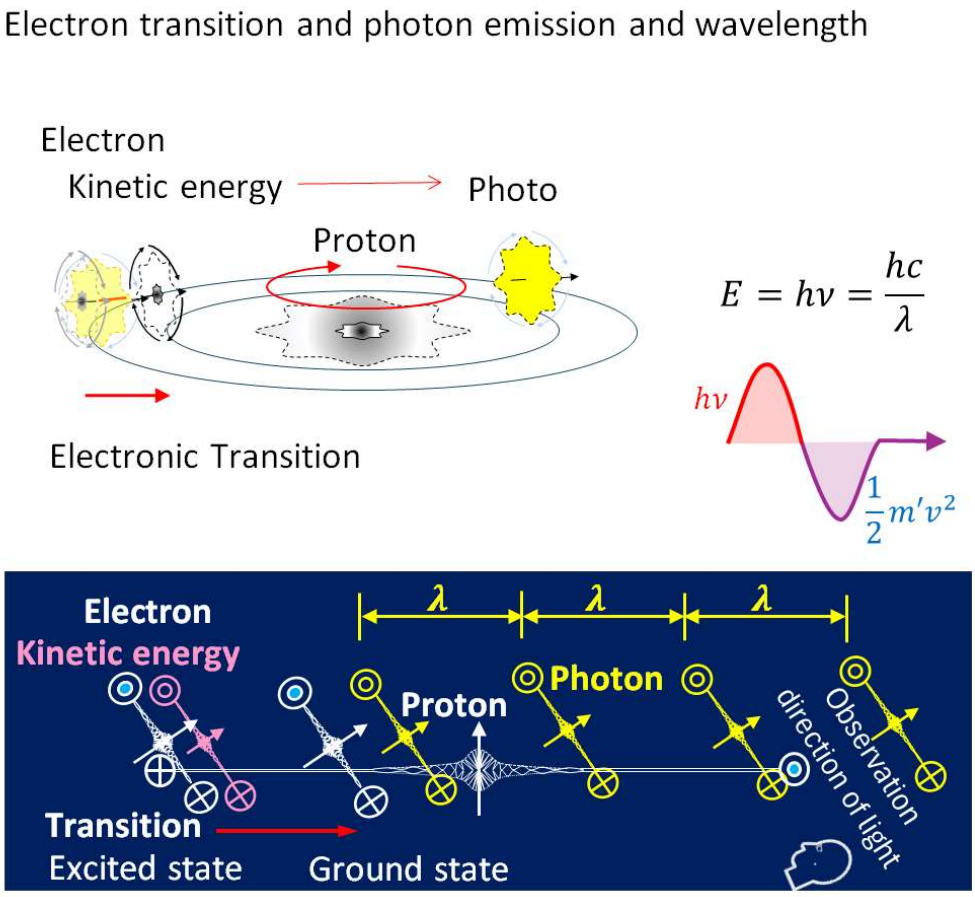


Fig.5.

Planck's constant h, Coulomb's constant, and electromagnetic interaction are the restoration from the distortion generated in the electron's foot. Also, the speed of light is the ratio of the delay in time it takes for a photon's foot to reach an observer to the distance to the photon. This is because the arrival of the foot of light is delayed due to the photon's foot distortion observing the side perpendicular to the direction of travel of the photon. It is shown in Figure 6. The speed of the photon inherits the speed of the electron just before it is separated.

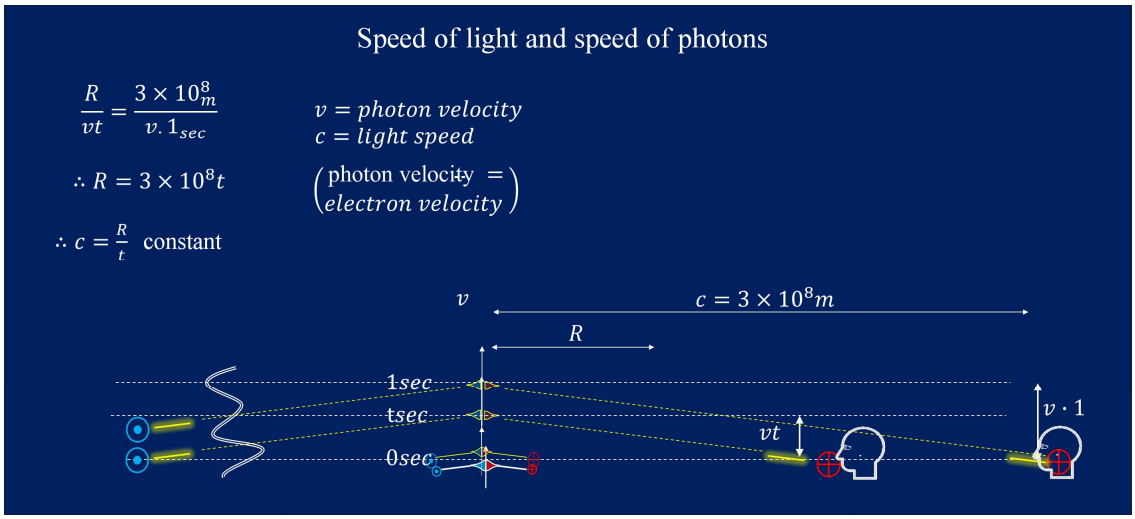


Fig.6

4. Conclusion

I have found that the fine structure constant originates from the distortion of the foot of the electron model of the energy body theory. It was then possible to show that the fine structure constant can be derived from Coulomb's law and Planck's constant.

5. Reference

Wikipedia; fine structure constant

6. Acknowledgements

I would like to thank “Physics in History” for giving me the opportunity to derive the fine structure constant.

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