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The Physical Significance of the Fine-Structure Constant

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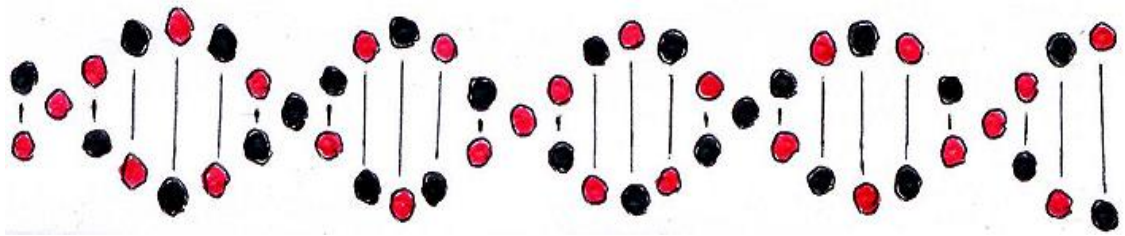
Abstract. **The physical significance of the *fine-structure constant,* 1/137, also known as the *Sommerfeld constant,* has not as yet been realized by the scientific establishment. This article will hence seek to solve the mystery in connection with the structure of the electromagnetic wave-carrying medium.**



Planck's Constant and Angular Momentum

I. It was demonstrated in, ***"The Apparent Dual Nature of Electromagnetic Waves"***, **[1]**, how the reduced Planck's constant, $\hbar$, referred to as *h-bar*, is in fact the angular momentum of the rotating electron-positron dipoles that comprise the electromagnetic wave-carrying medium. The equation,

$$\hbar = 2mcr \qquad \textbf{(1)}$$

applies where m is the mass of both an electron and a positron. These dipoles each consist of an electron and a positron in mutual circular orbit, but they are not held in orbit by electrostatic attraction. Instead, they are hemmed into their orbits by the centrifugal pressure pushing in on them from all sides by their immediate neighbours in the equatorial plane, **[2]**. The radius, r, of these orbits has to be 0.1932 picometres, hence leading to a circumference of 1.213 picometres, this being exactly half of the Compton wavelength, while the circumferential speed, c, of the electrons and positrons is equal to the speed of light. See, ***"The Double Helix Theory of the Magnetic Field"***, **[3]**, **[4]**.

Meanwhile, it was shown in Section **IV** of, ***"The Double Helix Theory of the Magnetic Field"***, **[3]**, how the outward centrifugal pressure in one of these compressed dipole orbits has a centrifugal potential energy equal to $2mc^2$, this being the energy, 1.02MeV, of the gamma photons that are needed to split one of these dipoles apart, **[5]**.

Electrostatic Potential Energy

II. The mutual electrostatic potential energy associated with the force of attraction between the electrons and positrons in each dipole is expressed by the equation,

$$V = e^2/4\pi\varepsilon_0 r \qquad \textbf{(2)}$$

where e is the electric charge of both an electron and a positron, ε_0 is the permittivity of space, and r is the radius of the orbit, this being 0.1932 picometres.

The Ratio of the Two Kinds of Potential Energy

III. Consider the ratio, α, of the electrostatic potential energy in Section **II** to the centrifugal potential energy in Section **I**. This ratio takes the form,

$$\alpha = e^2/(4\pi\varepsilon_0 r \times 2mc^2) \qquad \textbf{(3)}$$

Substituting the reduced Planck's constant equation **(1)** into equation **(3)** leads to,

$$\alpha = e^2/(4\pi\varepsilon_0 \hbar c) \qquad \textbf{(4)}$$

This is the fine-structure constant equal to 1/137.

Conclusion

IV. The *fine-structure constant*, equal to 1/137, also known as the *Sommerfeld constant*, is simply the ratio between the electrostatic potential energy and the centrifugal potential energy in the rotating electron-positron dipoles that fill all of space and which comprise the electromagnetic wave-carrying medium. The dipoles in question each constitute an electron in circular orbit with a positron, where the circumference is exactly half of the Compton wavelength, and where the circumferential speed is equal to the speed of light. In the absence of this arrangement, there could be no other way to explain the connection, as is implied by the fine-structure constant, between the speed of starlight and the charge of an electron at a point in space where the starlight is passing through. Space has to be filled with rotating electron-positron dipoles in order to make any sense out of the fine-structure constant.

References

[1] Tombe, F.D., ***"The Apparent Dual Nature of Electromagnetic Waves",*** (2021)
https://www.researchgate.net/publication/356194121_The_Apparent_Dual_Nature_of_Electromagnetic_Waves

[2] Whittaker, E.T., ***"A History of the Theories of Aether and Electricity"***, chapter 4, pp. 100-102, (1910)
"All space, according to the younger Bernoulli, is permeated by a fluid aether, containing an immense number of excessively small whirlpools. The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools; for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools."

[3] Tombe, F.D., ***"The Double Helix Theory of the Magnetic Field"***, (2006)
Galilean Electrodynamics, vol. 24, number 2, p.34, (March/April 2013)
https://www.researchgate.net/publication/295010637_The_Double_Helix_Theory_of_the_Magnetic_Field

[4] Tombe, F.D., ***"The Double Helix and the Electron-Positron Aether"***, (2017)
https://www.researchgate.net/publication/319914395_The_Double_Helix_and_the_Electron-Positron_Aether

[5] Tombe, F.D., ***"The Positronium Orbit in the Electron-Positron Sea"***, (2020)
https://www.researchgate.net/publication/338816847_The_Positronium_Orbit_in_the_Electron-Positron_Sea