An Equation of Six Eminent Constants

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ABSTRACT

A simple mathematical relationship exists between six eminent physical constants.

SIX EMINENT PHYSICAL CONSTANTS:

A simple equation is comprised of six eminent physical constants. The constants are:

e = the charge of an electron: $1.6021917 \times 10^{-19}$ C

h = Planck's constant: 6.626196×10^{-34} J*S

c = the velocity of light: 2.9979250×10^{8} M*S^{-1}

ε_0 = the permittivity of free space: $8.854187817 \times 10^{-12}$ F*M^{-1}

δ = 4.6692016…Feigenbaum's constant (unitless)

π = 3.14159....Pi

Four of these constants can be found in the Sommerfeld Fine Structure Constant. (1)

FINE-STRUCTURE CONSTANT

The fine-structure constant, alpha, (α) is a dimensionless quantity comprised of the four physical constants, electronic charge (e), speed of light in a vacuum (c), the Planck constant (h), and the permittivity of free space (ε_0)[1]. Alpha was discovered when it first appeared in connection with the fine structure of atomic spectra. The fine-structure constant is sometimes also referred to as the electromagnetic coupling constant. It characterizes the force of coupling between the elementary electric charge and the electromagnetic field. The equation for the fine structure constant is:

$$\alpha=e^2/2hc\varepsilon_0 \qquad (2)$$

Where:

e = the charge of an electron: $1.6021917 \times 10^{-19}$ C

h = Planck's constant: 6.626196×10^{-34} J*S

c = the velocity of light: 2.9979250×10^{8} M*S^{-1}

ε_0 = the permittivity of free space: $8.854187817 \times 10^{-12}$ F*M^{-1}

therefore: $\alpha = 0.007297353 \approx 1/137$

In some cases, the fine-structure constant is expressed as $\alpha^{-1} \approx 137$.

The equation $\alpha=e^2/2hc\varepsilon_0$ contains Planks Constant, a fundamental constant of quantum physics (h), of relativity, the speed of light (c) and of electromagnetic theory (e and ε_0). The constant α is also unit-less, as shown here:

$$=C^2/(V*C*S)(M*S^{-1})((C/V)M^{-1}) \qquad (2)$$

$$= C^2/(V*C*S)(S^{-1})(C/V)=C^2/(V*C)(C/V)=C^2/(C*C) = \text{unit-less}$$

A appears in several equations which describe the hydrogen atom, they are:

First Bohr orbit:	$a_0 = \lambda'_c/\alpha$	(2)
Ground state energy:	$-\omega_0 = -1/2\alpha^2 m_0 c^2$	(2)
Rydberg constant:	$R\gamma_\infty = \alpha 2/4\pi\lambda'_c$	(2)
Orbital velocity:	$v = \alpha c$	(2)

Where:

λ'_c = Compton wavelength divided by 2π

m_0 = the electron rest mass

FEIGENBAUMS CONSTANT

The Feigenbaum scaling constant[2], $\delta = 4.669201609$ was discovered by Mitchell Feigenbaum in the mid 1970's while doing research at Los Alamos on turbulence. He discovered that as a system goes into turbulence (chaos), an infinite sequence of bifurcations or period-doublings occur. Figure 1 is a bifurcation tree illustrating the period doubling sequence. Bifurcations occur simultaneously; each branch is a "scale model" of the previous branch and the scaling is the Feigenbaum constant, $\delta = 4.6692016\ldots$

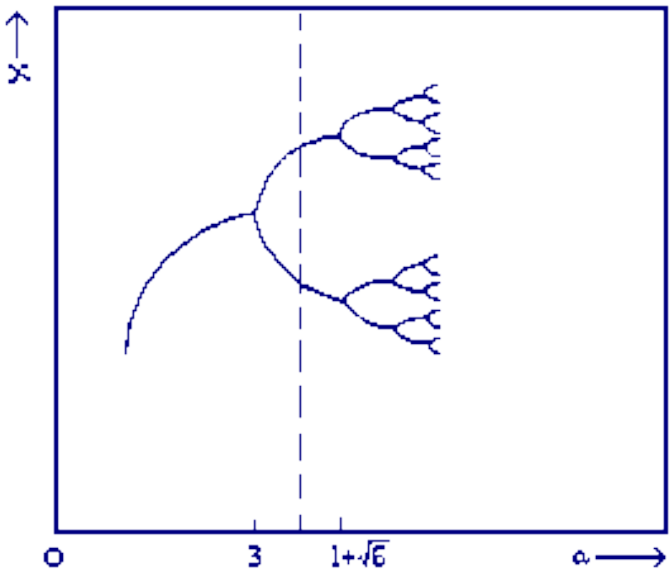

FIGURE 1: Bifurcation tree illustrating the period doubling sequence.

To quote Feigenbaum:

"What is quite remarkable (beyond the fact that there is always a geometric convergence) is that, for all systems under going this period doubling, the value of δ is predetermined at the universal value $\delta = 4.6692016\ldots$"[3]

A RELATIONSHIP

A simple mathematical association exists between the fine-structure constant, α, and Feigenbaum's scaling factor, δ:

$$\delta' = (1/2\pi\alpha))^{1/2} = 4.670114 \approx \delta = 4.669201609 \quad (3)$$

$$\delta' - \delta = 0.000912$$

EQUATION OF SIX EMINENT CONSTANTS:

The six eminent physical constants are:

e = the charge of an electron: $1.6021917 \times 10^{-19}$ C

h = Planck's constant: 6.626196×10^{-34} J*S

c = the velocity of light: 2.9979250×10^{8} M*S^{-1}

ε_0 = the permittivity of free space: $8.854187817 \times 10^{-12}$ F*M^{-1}

$\delta = 4.6692016\ldots$Feigenbaum's constant (unitless)

$\pi = 3.14159....$Pi

The equation is:

$$\delta = (1/(2\pi\, e^2/2hc\varepsilon_0))^{1/2}$$

Another form of the equation is:

$hc\varepsilon_0=\pi e^2\delta^2$

π and δ are both unit-less… the other constants units are $(V*C*S)(M*S^{-1})((C/V)M^{-1}) = C^2$

$(V*C*S)(M*S^{-})((C/V)M^{-1}) = (V*C)(M)((C/V)M^{-1}) = (V*C)(C/V) = (C)(C) = C^2$

CONCLUSION

There is a simple numerical relationship between four eminent physical constants, electronic charge (e), speed of light in a vacuum (c), the Planck constant (h), the permittivity of free space $(\varepsilon_0)^1$ and two unit-less constants, Feigenbaum's number (δ) and Pi (π) .

When all six eminent physical constants are considered, the final equation becomes $hc\varepsilon_0=\pi e^2\delta^2$.

REFERENCES

[1] Feigenbaum's Constant and the Sommerfeld Fine-Structure Constant**,** Mario Hieb (1995)

[2] Dictionary of Physics, Third Edition, pg. 215

[3] Chaos, Making a New Science, James Gleick, Penguin Books, pg. 174

[4] Universal Behavior in Nonlinear Systems, Mitchell J. Feigenbaum, Los Alamos Science1 4-27 (1980)