# RELATIONSHIP BETWEEN THE FUNDAMENTAL CONSTANTS OF PHYSICS

The fundamental classical equations of physics describing Newtons universal law of force of gravitational attraction, the law of force for the electrical and magnetic fields have defined within them, a constant of proportionality that gives them a value depending upon the units used. Force, for gravitational and electro-magnetic fields are proportional to the inverse of the square of the distance between interacting charges, and have a physical constant in the mathematical equation introduced to describe the force to give the force of attraction or repulsion between two like fields associated with two entities.

For gravity, the force between two entities of mass M and m that are separated by a distance r is given by

$$F = G \frac{M\,m}{r^2} \qquad \text{F01}$$

where G is a constant of proportionality known as the gravitational constant.

For the electric field between two entities of electric charge Q and q, that are separated by a distance r is given by

$$F = C \frac{Q\,q}{r^2} \qquad \text{F02a}$$

where C is a constant of proportionality known as Coulombs constant of proportionality. This equation of force is expressed often in the form

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Q\,q}{r^2} \qquad \text{F02}$$

where $\varepsilon_o$ is called the permittivity of space.

For a magnetic field generated by a moving electric field such as electrons moving within a conducting wire, the equation of force per unit length between two parallel wires, one with current I and the other with current I is given as

$$F = k \frac{Q\,q}{r^2} \qquad \text{F03a}$$

where k is a constant of proportionality. This equation of force is expressed often in the form

$$F = \frac{\mu_0}{2\pi} \frac{Q\,q}{r^2} \qquad \text{F03}$$

Where $\mu_o$ is called the permeability of space.


Equations F01, F02, and F03 all look very similar and suggest that they are related in some manner. Because a magnetic field is generated by and moving electric field, and an electric field is generated by a moving magnetic field, these two fields are related by the movement of each field relative to the other. Through the works of Faraday and Maxwell, it was found that another constant, the speed of light is given by the values $\varepsilon_o$ and $\mu_o$ through the mathematical equation where c is the speed of light in a vacuum.

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \qquad \text{F04}$$


So there is seen an immediate relationship between three constants of physics, the speed of light and the permeability and permittivity of space.

The permeability and permittivity of space is defined by running a current through two parallel wires one meter apart to give a force of exaclty $2\times10^{-7}$ Newtons per meter of length of each wire. The current thus flowing is defined as one Ampere. Consequently, this gives a value for $\mu_o$ to be exactly $4\pi \times 10^{-7}$ N/m.

Thus the value of $\varepsilon_o$ is measured by this method and by calculating using relationship F04 to be ~$8.854187817\times10^{-12}$ $C^2/Nm^2$

By measuring the speed of light a constant value was found no matter how the experiment was conducted in a vacuum and is measured to be ~$2.99792458\times10^8$ m/s

The gravitational constant G is a measurement directly through experiment between two bodies of known mas and found to be ~6.6738x10-11 $Nm^2/kg^2$

In a Table the fundamental constants of proportionality for the common forces of gravity, electric, magnetic forces are

| | |
|---|---|
| Permeability of space $\mu_o \sim 4\pi \times 10^{-7}$ N/m | C01 |
| Permittivity of space $\varepsilon_o \sim 8.854187817 \times 10^{-12}$ C$^2$/Nm$^2$ | C02 |
| Gravitational Constant G $\sim 6.6738 \times 10^{-11}$ Nm$^2$/kg$^2$ | C03 |

and

| | |
|---|---|
| Speed of light c $\sim 2.99792458 \times 10^8$ m/s | C04 |

**Force**

By definition, the force on an entity is given by the relationship that force F, is the mass of an entity m, multiplied by its acceleration, a. Or F=ma. Substituting ma into the equations F01, F02 and F03 yield

$$a = G\frac{M}{r^2} \qquad \text{F10}$$

$$ma = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2} \qquad \text{F11}$$

$$ma = \frac{\mu_0}{2\pi}\frac{Qq}{r^2} \qquad \text{F12}$$

Immediately it can be seen that the acceleration, or result of a force due to gravity on an entity is independent upon its own mass, but is dependant upon the mass that it is interacting with. This is why in a vacuum, such as on the moon, a feather and a hammer accelerate towards the moon at the same rate.

However, the forces due to an electric or magnetic field is different, the rate of acceleration towards an entity is not only dependant upon its own charge, but that of its mass as well. This seems to be the inconsistency between electromagnetism and gravity.

**Relationship Between Gravitational constant and the speed of light**

Consider the similarity of the classical equation for gravity as given by F01 above to that of the electric and magnetic equations of force. Noting that Newtons law of gravity does not have a division by $4\pi$, consider introducing such a relationship into F01.

If the equation for the gravitational force was written in a manner similar to that for electric and magnetic field forces, then F01 could be thus written as

$$F = \frac{1}{4\pi g} \frac{M\,m}{r^2} \qquad\qquad \text{GC01}$$

where g is a modified gravitational constant similar to $\varepsilon_o$. Thus

$$g = \frac{1}{4\pi G} \qquad\qquad \text{GC02}$$

or

$$g \sim 1.1926 \times 10^9$$

This value is of the same order as the speed of light, and perhaps suggests a relationship. So assuming there is one, and it is a simple constant relationship given by

$$g = A \times c \text{ (speed of light)}$$

then find

$$A = \frac{c}{g} \approx 4$$

and it is found that therefore

$$g \approx 4c \text{ to within 1\% using a calculator}$$

or

$$c = \frac{1}{16\pi G} \qquad\qquad \text{GC03}$$

and Newtons equation of gravitational force can be rewritten as

$$F_g = \frac{1}{16\pi c} \frac{M\,m}{r^2} \qquad\qquad \text{GC04}$$

or using the permeability and permittivity of space expressing the speed of light

$$F_g = \frac{\sqrt{\mu_0 \varepsilon_0}}{16\pi} \frac{M\,m}{r^2} \qquad\qquad \text{GC05}$$

This thus suggests that gravity may be related to electromagnetism, and may even be a result of some kind of electromagnetic interaction.

If GC03, GC04 and GC05 are valid and true, then a common relationship between the major constants of Physics being gravity, electromagnetism and the speed of light is found. Implications of this is left for later.

## New way of writing physical constant for permittivity of space and speed of light

The permeability of space divided by the permittivity of space gives a value of ~ $1.414 \times 10^5$ , which is $\sqrt{2} \times 10^5$. to an accuracy less than 1%. This is not how this was found, as the number $4\pi/\sqrt{2}$ was being investigated for a different concept explained below, and it was seen that this number corresponded to the permittivity of space to the power $10^{-12}$. Thus the permittivity of space can be written as

$$\varepsilon_0 = \frac{4\pi}{\sqrt{2}} x \, 10^{-12} \qquad \text{APS01}$$

or

$$\varepsilon_0 = \frac{\mu_0}{\sqrt{2}} x \, 10^{-5} \qquad \text{APS02}$$

and since the speed of light is given by F04, an alternative method of writing the speed of light can be given by

$$c = \frac{1}{\sqrt{\frac{\mu_0^2}{\sqrt{2}} 10^{-5}}} \qquad \text{APS03}$$

=>

$$c = \frac{\sqrt{\sqrt{2} \, 10^5}}{\mu_0} \qquad \text{APS04}$$

or conversely

$$c = \frac{1}{\varepsilon_0 \sqrt{\sqrt{2} \, 10^5}} \qquad \text{APS05}$$

Substituting the value of APS04 into GC05 for the gravitational force gives

$$F_g = \frac{\mu_0}{16\pi \sqrt{\sqrt{2} \, 10^5}} \frac{M \, m}{r^2} \qquad \text{APS06}$$

=>

$$F_g = \frac{4\pi \, 10^{-7}}{16\pi \sqrt{\sqrt{2} \, 10^5}} \frac{M \, m}{r^2} \qquad \text{APS07}$$

or

$$F_g = \frac{10^{-7}}{4\sqrt{\sqrt{2} \, 10^5}} \frac{M \, m}{r^2} \qquad \text{APS08}$$

# Electron – Proton mass ratio

The ratio of mass of the proton to the electron is ~1836. Given that the forces of gravity, electrical charge and magnetism are proportional to $1/4\pi r^2$, which can be interpreted as being inversely proportional to the surface area of a sphere of radius r, then perhaps by some simple chance, could it be that the mass of a proton and electron are represented as being some function proportional to the volume of some sphere surrounding them. That is, the mass of the electron are proportional to some radius $r^3$.

Assuming that this is the case, then the ratio of mass proton/ mass electron is the cube of some value $x_{pm}$. To find $x_{pm}$, find (mass proton/ mass electron)$^{1/3}$

or

$$x_{pm} \approx \sqrt[3]{1836} \qquad\qquad \text{EPS01}$$

=>

$$x_{pm} \approx 12.245 \approx (4\pi)^3 \qquad\qquad \text{EPS02}$$

to within +8% of the true measured value.

This is not as precise a possible relationship as that of the gravitational constant being a function of the speed of light and the permittivity and permeability of space given in F02a to F03, nor even the value of the permittivity of space given by APS01, but if may be in the right direction of what mass is. That is, the mass of the fundamental particles may related to a volume or density of space, and thus are not point particles, but are entities that occupy a space.

# Concept of charge density

A proton, and an electron each have the same overall value of electrical charge interacting with each others electrical fields and with magnetic fields according to the physical experiments conducted, and the observations obtained to create the classical and quantum filed theories that dominate physics.

But having the same overall charge may not not mean that protons and electrons have the same electrical field at some radius $r_0$ surrounding them where the electrical field may be of a different density or flux, but the overall integration over the sphere at that radius is the same. Consider that if this is true, then consider that the differing gravitational charge, mass, of the proton and electron is a result of some form of interaction or self interaction of electrons and protons.

Consider that the electron has an electric field surrounding it given by

$$E_e = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_e^2} \qquad\qquad \text{CC01}$$

and that of the proton has an electric field surrounding it given by

$$E_p = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_p^2} \qquad\qquad \text{CC02}$$

If there exists an electric field density for each entity, consider that a proton has an electric field density that is $N_d$ multiple of that of the electron, or

$$E_p = \frac{1}{4\pi\varepsilon_0}\frac{N_d q}{r_p^2} \qquad\qquad \text{CC03}$$

Consider there exists a point between the electron and proton where $E_e = E_p$, or

$$\frac{1}{4\pi\varepsilon_0}\frac{q}{r_e^2} = \frac{1}{4\pi\varepsilon_0}\frac{N_d q}{r_p^2} \qquad\qquad \text{CC04}$$

=>

$$\frac{1}{r_e^2} = \frac{N_d}{r_p^2} \qquad\qquad \text{CC05}$$

=>

$$r_p^2 = N_d r_e^2 \qquad\qquad \text{CC06}$$

Consider that $N_d$ can only be of an integer value, $N_d$ = 1,2,3, ….,

When $N_d$ = 1, charge density of electron = charge density proton and $r_p = r_e$.

When When $N_d$ = 2, charge density of proton = charge density electron and $r_p = \sqrt{2}\, r_e$.

And when substituting $\sqrt{2}$ for $N_d$ in CC04, a value of the inverse of $\varepsilon_0$ ignoring power terms was noticed, and the fact that $\varepsilon_0$ = $4\pi/\sqrt{2}$ x $10^{-12}$ discovered.

If another stable particle is found to exist that has a mass much greater than the proton and of electric charge value ± q, then assuming it has an electric field density that electric field density may be the same as an electron at a radius of $\sqrt{3}$ of that of an electrons

## Mathematical Equivalent numbers

For any number N that can be expressed as

$$N = m C \sqrt{m}$$ where C is a constant, and m is an integer or non irrational number

it can also be expressed as

$$N = \frac{m^2 C}{\sqrt{m}}$$

or

$$mC \sqrt{m} = \frac{m^2 C}{\sqrt{m}}$$

thus Note :

$$2\pi\sqrt{2} = \frac{4\pi}{\sqrt{2}}$$

and can substitute $2\pi\sqrt{2}$ where $\frac{4\pi}{\sqrt{2}}$ occurs

# Electric Displacement Concept

## D = εE

### The difference between **D** and **E**.

D is the electric displacement field, or commonly, the flux density, and $E$ is the field intensity. There is a fundamental difference between them which will be understood to certain extent as one goes through the following answer. Consider a point charge of $Q$ coulombs. This means that the number of flux lines emitted by the charge is $Q$ coulombs.
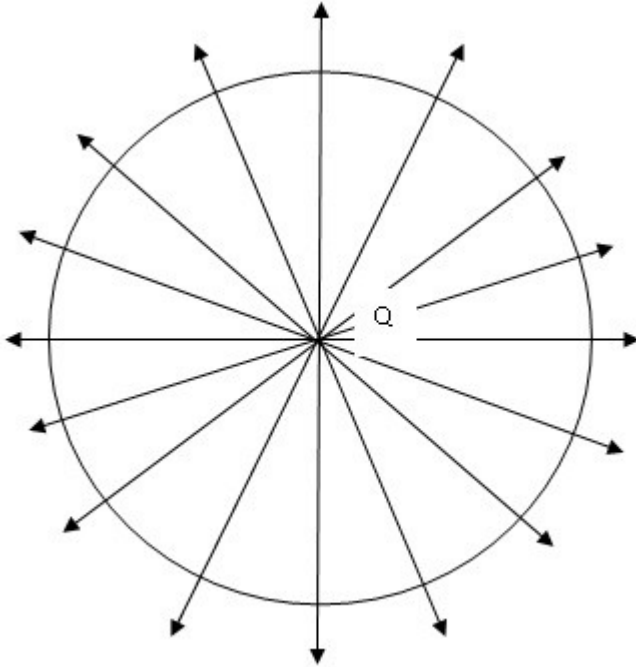


Let the hypothetical sphere shown in figure has a radius $r$

. Then $D$ is given by

$$D = Q\ 4\pi r^2$$

That is, $D$ is the number of flux lines passing per unit area. So, to get an intuitive grasp, interpret $Q$ as a number (number of flux lines) and $D$ as a number density (number of flux lines per area). Now, what about $E$? $E$, which is the electric field intensity, is actually a force ($E$ is defined as force per coulomb) per flux line, that is the force carried by each flux line. So, the relation $D=\varepsilon E$ connects the number density of flux lines, D, with a force per flux line term, $E$. Now, the permittivity $\varepsilon$ is defined as the ability to pass lines of electric flux through it. This is a qualitative way of saying. Quantitatively, it can be seen as the ratio $DE$, that is, $\varepsilon$ is the number of electric flux lines (unit is coulomb, as mentioned earlier) passing through unit area for unit force/flux (which is unit field intensity). That is, say $\varepsilon=5$ (this value of $\varepsilon$ is hypothetical and considered only for the sake of explanation) means, there are 5 flux lines in a unit area considered normal to an electric field with each flux line carrying $1N$ force.