

Unifying the four forces

The purpose of this article is to define and unify the four forces and the physical properties in terms of two fundamental properties, **time periods and time intervals**, and to explain why the physical constants **e, 2 pi, h, C, G, Z, e^o, u,** and \hbar arise in physics.

It is also my intent to provide readers with a clear, concise, graphic overview of physics. I hope to accomplish these ends by developing unique “**Physical Property Charts**” that show the relationships between the physical properties much as the Periodic Chart shows the relationships between the elements.

The term “physical property” as used in this article means those qualities used in physics, engineering, and electronics to model the relationships between objects. These properties include time, space, mass, force, energy, charge, voltage, and current.

The graphics that represent the physical properties and concepts used in this article are color coded to reflect the complexity of the physical properties or concept. The color code can be remembered by referring to the familiar mnemonic “ROY G. BIV” used to remember the primary colors of the visual spectrum: red, orange, yellow, green, blue, indigo and violet. The concepts become more complex as they approach the violet end of the spectrum. Some words and phrases that might otherwise be neglected are displayed **bold** in order to emphasize certain points.



Figure #1

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Dimensional Analysis is physics.

Man is hardwired to perceive objects that vary in time and space, and he has developed an enormous vocabulary of objects (Nouns) and words that describe how objects vary (Verbs). The physical properties, a small subset of these nouns and verbs, are used in physics to model man's world.

James Clerk Maxwell found that a small sub-set of the physical properties called **fundamental properties** could serve as **pointers** to the other physical properties. Maxwell selected time, distance and mass to be his fundamental properties and he came up with two constants (Permittivity and permeability) in order to couple the electric and magnetic properties to these properties. Maxwell's system is now called "Dimensional Analysis". Figure #2 depicts how Maxwell might have viewed the relationships between time, distance and mass.

Although most people think of physics in terms of equations, "Dimensional Analysis" is the essence of physics. Any language, be it a plain language, a mathematical language or a computerlanguage, can be used to express the relationships between the physical properties, and the physical properties can be expressed in any desired units, but models and theories must be dimensionally correct, or else they will not be able to model Nature accurately and consistently.

Units are **politics**.

The ways of expressing relationships between physical properties are **languages**,
Dimensional Analysis is physics.

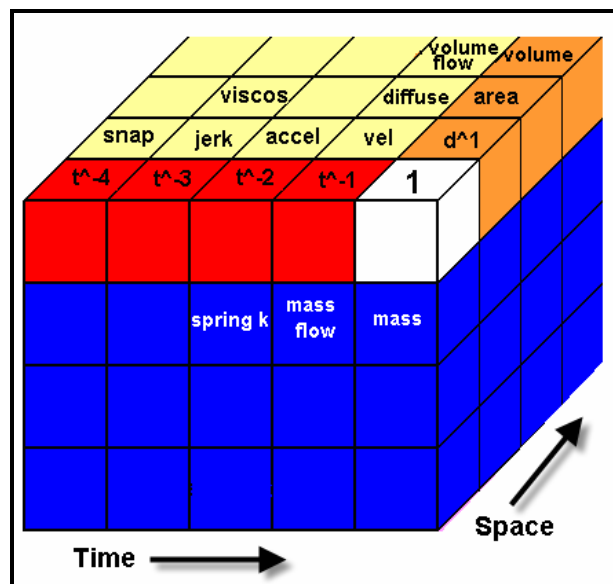


Figure #2

Functions of x and y

The “Property Charts” in this article are two dimensional charts that display powers of “pointer properties” on the vertical and horizontal axis, and the properties “pointed to” at x and y intercepts.

Chart #1 demonstrates this by displaying powers of “x” from left to right, and powers of “y” from bottom to top. The functions of x and y would be displayed in the yellow cells. A few functions are shown to emphasize the point.

Note that the ROY G BIV color code is used to make the point that the order of complexity is x, y, and functions of x and y, in that order.

Also note that “1” is the center of the chart as x^0 and $y^0 = 1$.

			y^3			x^3y^3
y^2/x^3			y^2		x^2y^2	
		y/x	y^1			
x^{-3}	x^{-2}	x^{-1}	1	x^1	x^2	x^3
		$1/x^y$	y^{-1}	x/y		
			y^{-2}			
			y^{-3}			

Chart #1

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Functions of periods and intervals

As this article deals with physical properties rather than mathematics, and as times are the most fundamental of all physical properties, on Chart #2 I have substituted p for x and i for y , where “ p ” is the symbol for time period and “ i ” is the symbol for time interval.

As this displays the relationships between time periods and time intervals I call this the “Time Domain”. As all properties in the time domain can be quantized using the standard time units from a single clock, the same clock used to quantize time periods (Pure times) is used to quantize time intervals (Pure spaces).

The time domain is the simplest and most fundamental expression of the physical properties, and the properties in the time domain can be quantized most precisely as they are referenced to a single standard clock.

Time periods, time intervals, and other physical properties are sometimes scaled in radian units and sometimes scaled in cycle units. This makes it necessary to sometimes use 2π equations and quantities in order to adjust the units.

			i^3			$p^3 \cdot i^3$
i^2/p^3			i^2		$p^2 \cdot i^2$	
		i/p	i^1			
p^{-3}	p^{-2}	p^{-1}	1	p^1	p^2	p^3
		$1/p \cdot i$	i^{-1}	p/i		
			i^{-2}			
			i^{-3}			© 2006

Chart #2 (Time Domain)

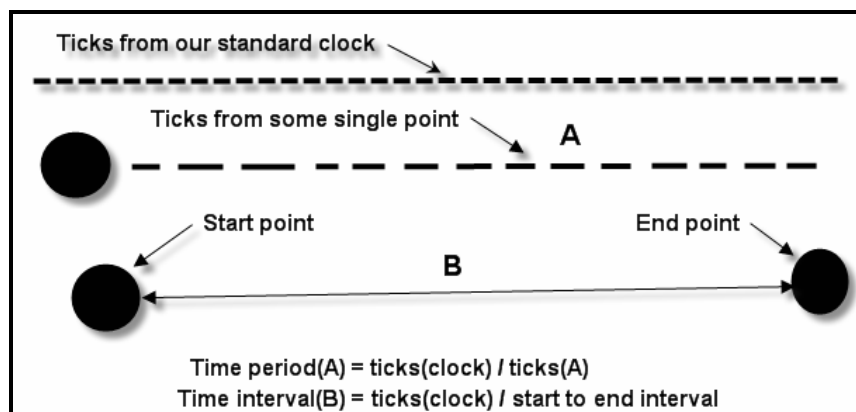


Figure #3

Functions of times and spaces

Time periods are associated with one point or body, and are pure times. Time intervals are associated with two points or bodies, and are pure spaces. In order to emphasize this, I have substituted “t” for “p” (Time for period) and “s” for “i” (Space for time interval) on chart #3.

			s^3			$t^3 s^3$
s^2/t^3			s^2		$t^2 s^2$	
		s/t	s^1			
t^{-3}	t^{-2}	t^{-1}	1	t^1	t^2	t^3
		$1/t*s$	s^{-1}	t/s		
			s^{-2}			
			s^{-3}			© 2006

Chart #3 (Space Domain)

The constants listed below will be referred to on the following pages:

-
- 2 pi - The number of radians in a circle.
 - C - The “speed of light”.
 - G - The universal gravitational constant.
 - Z° - The impedance of space constant.
 - Y° - The admittance of space constant
 - e° - The permittivity of space constant.
 - u° - The permeability of space constant.
 - h- Planck’s Constant
 - The fine structure constant

Important notes:

The number of radians in a circle is defined (2 pi).

The constants Cand Z° are defined.

The permittivity and permeability of space constants are defined by C and Z°.

e° = the permittivity of space constant = 1 / (C*Z°)

u° = he permeability of space constant= Z° / C

Y° = The admittance of space constant = 1 / Z°

Spaces (Distances and lengths) can be referenced to the time interval between two points, or to material standards like rulers and gage blocks. Measuring sticks, rulers, and material standards are nasty, temperature sensitive, acceleration sensitive, pressure sensitive, vibration sensitive, bending sensitive, contamination sensitive beasts. It is best to use time intervals as the measure of space, and set the constant “C” to some agreed on value, rather than referencing space to material objects, and this is what man has learned to do.

Functions of times and distances

In order to differentiate between time periods and time intervals, time intervals are commonly multiplied by a constant “C”, and called distances and lengths. Distances generally refer to the space between two bodies, while length generally refers to the space between the end points on a single body.

Distance (And length) = time interval * C

Chart #4 displays the space domain properties, as functions of time and distance (Or length). The common names of a few properties have been added to show their dimensions in terms of time and distance. I have used “d” (Distance) rather than “s” (Space) in order to emphasize that distances and lengths associated with material bodies are not spaces, but are analogs of spaces.

Note that area has the dimensions of d^2 , and volume has the dimensions of d^3 . As the understanding of the relationships between the physical properties evolved over thousands of years, each physical property acquired a name of its’ own that was unrelated to the property’s relationships to the other properties. Unfortunately science still clings to most of the popular names of the properties, rather than associating property names with the dimensions of the property.

velocity ³		Vol. flow	volume			
viscosity	velocity ²	diffusivity	area			
jerk	acceleration	velocity	d ¹			
t ⁻³	t ⁻²	t ⁻¹	1	t ¹	t ²	t ³
			d ⁻¹			
			d ⁻²			
			d ⁻³			© 2006

Chart #4 (Space Domain)

The relationship between mass and time-space

Chart #5 integrates the space domain properties with mass by using the relationship between time periods, time intervals and masses discovered by Kepler and explained by Newton. Kepler observed that a planet's radii cubed divided by the square of the planet's distance from the Sun, was a constant. Newton proposed that the mass of the Sun was a factor in this constant, and he came up with the universal gravitational constant "G" as the other factor.

Kepler: $k = \text{radius(planet)}^3 / \text{time(planet)}^2$

Newton: $\text{Mass(Sun)} * G = \text{distance(planet)}^3 / \text{time(planet)}^2$

Kepler's 3rd Law is usually expressed: $k = 4 * \pi^2 * \text{radius(planet)}^3 / \text{time(planet)}^2$
 The $4 * \pi^2$ is not needed if time is expressed in radians. In order to avoid superfluous constants, some period times in this article are expressed in radian units.

In keeping with the ROY G BIV color code, the mass domain properties are color coded blue to indicate that **the mass domain is more complex than the space domain, which in turn is more complex than the time domain**. Note that some of the cells are white in order to emphasize the relationships between the property domains.

The constant "G" came about because of the limitations of two body math. This limitation forced Newton to treat one body in a two body interaction, as fixed in time and space. As he did not have the tools to model the dynamics of two bodies, he held the Sun fixed in time and space, and had the planets moving about the Sun. As Newton gave the times and distances to the planets, he had to give the Sun the "G" so his equation would balance.

The mass domain properties, which are color coded blue, can be looked at in terms of either varying or fixed in time and space. The constant "G" comes into play when a mass is perceived to be fixed in time and space. In other words, in a two body interaction, the body perceived to be varying gets the distance and the time, and the body perceived to be fixed in time and space gets the "G". For example in the Sun-Earth system, the Earth is perceived to be orbiting the Sun so it gets the 365.25 days and the 93,000,000 miles, and as the Sun is perceived to be fixed in time and space and it gets the "G".

power	energy	ang mom	mom iner				
	force	momentum					
	spring k	mass flow	mass	Vol. flow	volume		
	pressure	viscosity	phi	diffusivity	area		
		jerk	acceleration	velocity	d^1		
t^-5	t^-4	t^-3	t^-2	t^-1	1	t^1	t^2
					d^-1		
					d^-2		© 2006

Chart #5 (Mass domain)

Integrating the electro-magnetic properties

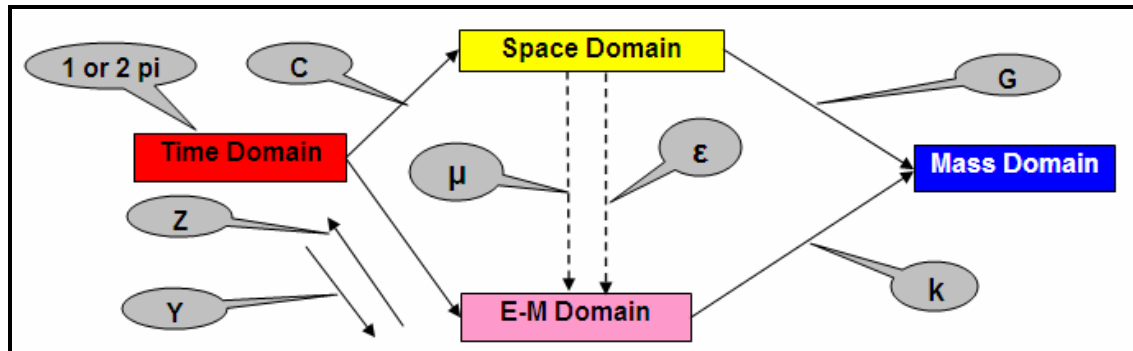


Figure #4

Figure #4 outlines how the property domains are linked by constants. The arrow direction denotes multiplication, opposite the arrow denotes division.

For example, multiplying a time interval in the time domain by “C” expresses it as a distance in the space domain, and multiplying distances by Maxwell’s permeability and permittivity constants expresses the distances as inductances and capacitances in the electro-magnetic domain.

$$\begin{aligned} \text{distance} &= \text{time interval} * C \\ \text{capacitance of space} &= \text{distance} * \epsilon^{\circ} \\ \text{inductance of space} &= \text{distance} * \mu^{\circ} \end{aligned}$$

Inductance and capacitance couple to the time domain by the following relationships.

$$\begin{aligned} \text{time interval} * \text{impedance} &= \text{inductance (L)} \\ \text{time interval} / \text{impedance} &= \text{capacitance (Cap.)} \end{aligned}$$

As both permittivity and permeability are defined in terms of C and Z^o, only one constant Z^o or 1/ Z^o (Y^o) is needed to merge the electro-magnetic properties with the time and space domain properties.

Either Z^o or Y^o can be used as the linking constant depending upon how one prefers to visualize the relationships between the physical properties. The **admittance of space constant** Y^o is to be preferred as it couples fundamental time intervals to a defined property (capacitance) just as just as “C” couples fundamental time intervals to defined spaces. Although complex properties are decomposed when searching for a model, a useful model should define the more complex in terms of the less complex.

$$\begin{aligned} \text{Capaci-tance} &= \text{time interval} * Y^{\circ} \\ \text{Dis-tance} &= \text{time interval} * C \end{aligned}$$

Comparing the Domains

Chart #6a and Chart #6b show how the electro-magnetic properties merge with the mass domain properties just as Chart #5 showed how the space domain properties merged with the mass domain properties. Chart #5 is repeated below Chart #6 in order to show the symmetry between the space domain and the electro-magnetic domains. As indicated, the Time-Conductance-Mass domain is preferred over the Time-Impedance-Mass domain.

power	energy	ang mom	mom iner		L ⁵		
	force	momentum			L ⁴		
Poynting	spring k	voltage	flux		L ³		
	pressure	E field	current	charge	L ²		
			H field	impedance	L ¹		
t ⁻⁵	t ⁻⁴	t ⁻³	t ⁻²	t ⁻¹	1	t ¹	t ²
					del	conductance	capacitance
					laplacian		
					L ⁻³		© 2006

Chart #6a (The Time-Impedance-Mass domain)

power	energy	ang mom	mom iner		cap ⁵		
	force	momentum			cap ⁴		
Poynting	spring k	current	charge		cap ³		
	pressure	H field	voltage	flux	cap ²		
			E field	admittance	cap ¹		
t ⁻⁵	t ⁻⁴	t ⁻³	t ⁻²	t ⁻¹	1	t ¹	t ²
					del	impedance	inductance
					laplacian		© 2006

Chart #6b (The Time-Conductance-Mass domain)

power	energy	ang mom	mom iner				
	force	momentum					
	spring k	mass flow	mass	Vol. flow	volume		
	pressure	viscosity	phi	diffusivity	area		
		jerk	acceleration	velocity	d ¹		
t ⁻⁵	t ⁻⁴	t ⁻³	t ⁻²	t ⁻¹	1	t ¹	t ²
					d ⁻¹		
					d ⁻²		© 2006

Chart #5 (Time-Space-Mass domain)

Integrating the weak and strong forces

As shown in Figure #4, the space domain is defined by time and a constant “C”, and the electro-magnetic domain is defined by time and a constant “Z”. If this pattern holds true, the weak force and the strong force domains can be defined in terms of time and constants as suggested in Figure #5.

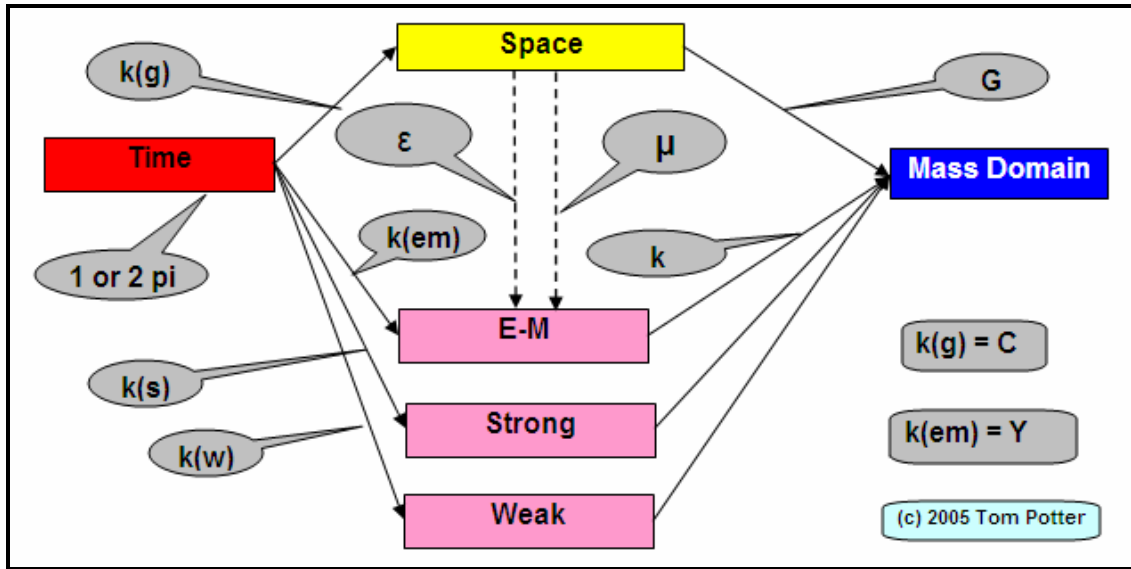


Figure #5

Chart #7 outlines the general mapping of the gravitational (Space), electro-magnetic, strong and weak force domains onto the mass domain. Time periods and time intervals form the basic structure of Nature. The interval/period ratio is a tangent function. Intervals are multiplied by a force domain unit constant (Gravitational, E-M, weak or strong). The mass domain group property (Color coded blue) is multiplied by the constant “G” if the mass involved is perceived to be fixed in media. Periods and intervals form the structure of media. Note that if all four forces were set to the same units [$k(g) = k(em) = k(s) = k(w)$] Chart #7 would apply to all forces and forces would be distinguished by numeric range rather than by a separate force name.

power	energy	ang mom	mom iner		$i * k(x)^5$		
	force	momentum			$i * k(x)^4$		
Poynting	spring k	point flow	point	flow	$i * k(x)^3$		
	pressure	ortho	MF	flux	$i * k(x)^2$		
		jerk	field	tangent	$i * k(x)^1$		
t^{-5}	t^{-4}	t^{-3}	t^{-2}	t^{-1}	1	t^1	t^2
					del		
					laplacian		© 2006

Chart #7 (The Time-Forces-Mass domain)

The rationale for the four force domains

The concept of the space (Gravitational) domain was formed by the historical observations accessible to man's senses, and caters to man the animal as it is needed to rationalize the perception that objects exist and convey changes from causes to effects. As man is hardwired to try to be conserved (Self-preservation), he constructs realities in which conserved objects (As he would like to be) vary in a neutral media (Time, space, and flux), that does not impact his immortality. **The space force domain deals with changes occurring at man's sensory level.**

The concept of the electro-magnetic domain was thrust upon man when Maxwell introduced his electro-magnetic constants (Permeability and permittivity), and observed that the product of his constants was a velocity. He proposed that this velocity was the speed at which changes were transferred from causes to effects by electro-magnetic waves, and he recognized that light was one expression of these waves and that other expressions (Wavelengths) were possible. The success of Maxwell equations and Dimensional Analysis forced man to adopt an alternate way to view how changes were conveyed from causes to effects. The electro-magnetic domain was formed by observations not directly accessible by man's senses, and deals with causes and effects at the atomic level. Maxwell also postulated point objects that could be assembled into more complex objects, but the technology at that time did not allow man to examine the inner workings of atomic nuclei and atomic particles. **The electro-magnetic force domain deals with changes at the atomic level.**

The concept of the strong force domain began to emerge in 1911, after Ernest Rutherford observed the recoil of alpha particles from thin gold foils and proposed the nuclear model of the atom. A wide range of models and theories have been used to describe how changes are conveyed from causes to effects at the sub-atomic level. **The strong force domain deals with changes at the nuclear level.**

The concept of the weak force domain came about when experimenters observed that some atomic particles spontaneously disintegrate into other particles. **The weak force domain deals with changes at the particle level.**

Explaining “k”

The Complementary Principle proposes that causes have the same effects whether tracked via the space domain or the E-M domain. Note that a constant “k” appears in Figure #4. If the Complementary Principle holds, the following equation should apply:

$$C * G = k * Y$$

giving a value of 7.53546360 for k.

The following electro-magnetic/mass domain equations are well proven:

$$\text{power} = \text{current}^2 * \text{impedance}$$

$$\text{energy} = \text{power} * \text{time}$$

And Kepler's 3rd Law is well proven:

$$k = 4 * \pi^2 * \text{radius(planet)}^3 / \text{time(planet)}^2$$

So the relationships between these properties, and other properties closely related to them, are well established.

Times are commonly expressed in radian units, as in Kepler's Equation, whereas most measurements in the electro-magnetic domain are expressed in cyclical units. This accounts for part of the constant “k” but not all of it.

Another correction that must be made to get the space and electro-magnetic domains balanced is to consider how properties are measured when establishing the connection between the various units in each domain. Voltage s, currents and other properties in the E-M domain are linked to the mass domain properties in terms of their “heating” or RMS (Root mean squared) values, whereas celestial measurements are expressed in average values. The RMS value for a pure sine wave is .707, and the average value is .636

“k” adjusted for the 2 pi factor, and the wave form difference is:

$$k = 2 * \pi * .707 / .636 = 6.98461008$$

As can be seen, this still leaves a difference to be accounted for.

$$x = 7.53546360 / 6.98461008 = 1.07886675$$

It could be that the difference can be accounted for by the geometry of systems of various magnitudes (Atomic size systems vs. celestial size systems). Also, the value of G has been called into question by new measurements from respected research teams in Germany, New Zealand, and Russia, and a different value of “G” would affect the difference, and the frame of reference used may enter into the picture. For example, physicists use the Earth's frame for local phenomena, and the solar system barycentric frame for other planetary system phenomena, in order to get results that agree with the predictions of relativity.

Explanations of Planck's Constant and the fine structure constant, and a summary to follow.